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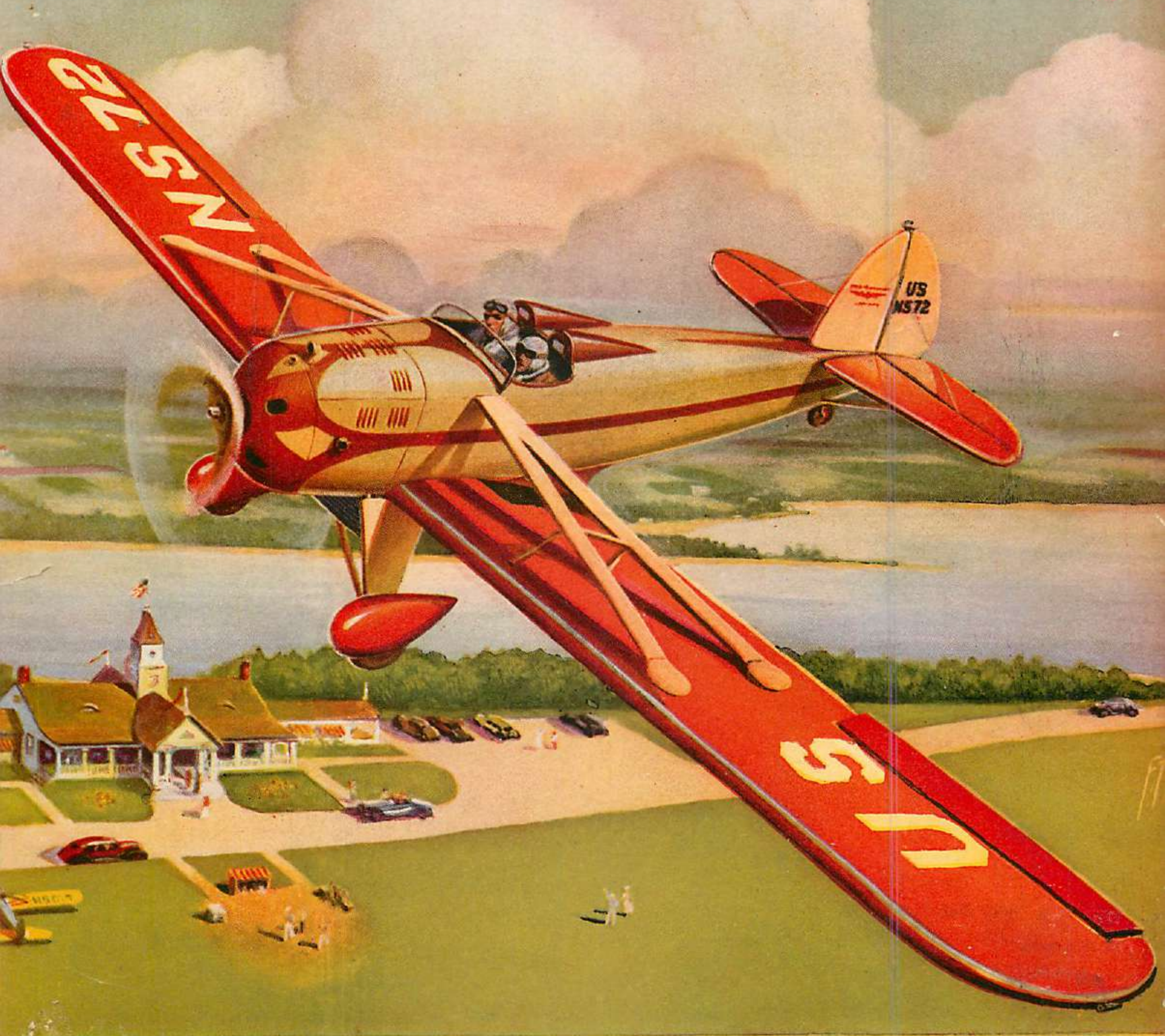
AIR TRAILS

OMPLETE **BILL BARNES** AIR NOVEL

THE BLACK HAWK
by George L. Eaton

MAY
1937



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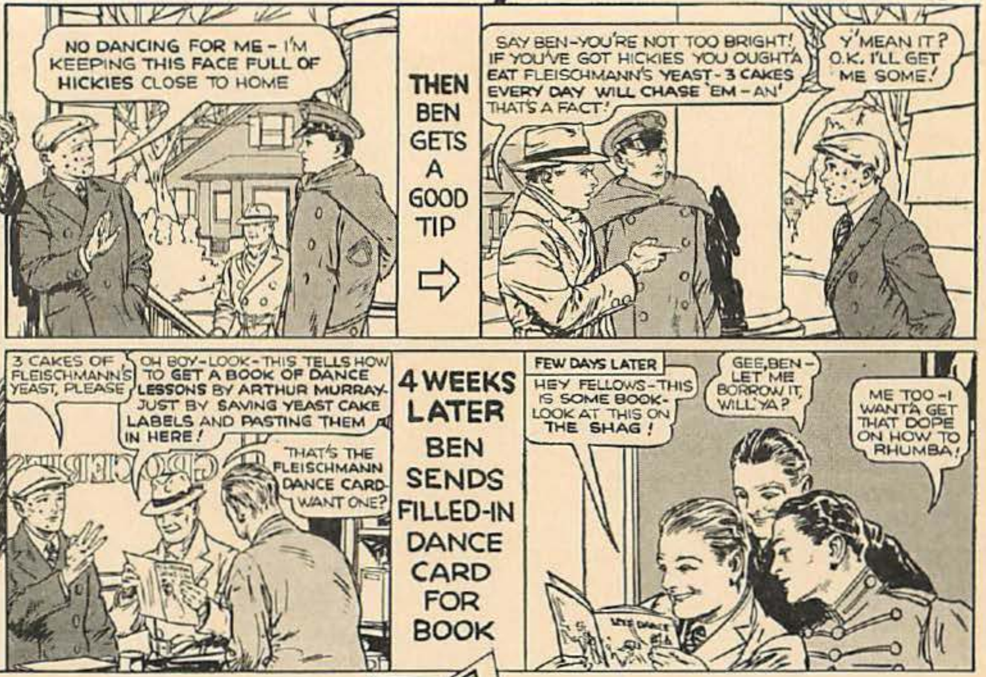
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Volume VIII No. 2
May, 1937

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Single Copy, 15 Cents
Yearly Subscription, $1.50

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We do not accept responsibility for the return of unsolicited manuscripts. To facilitate handling, the author should inclose a self-addressed envelope with the requisite postage attached.

STREET & SMITH PUBLICATIONS, INC.
79 Seventh Avenue
New York, N. Y.

CONTENTS

4 Stories:

BILL BARNES AIR NOVEL:

THE BLACK HAWK 8
At breakneck speed the Lancer dropped into a power dive—faster—faster until the air shrieked and howled as it passed—and Bill Barnes grew faint——
by George L. Eaton

Boomerang . . . . *by H. P. Montanye* 20
"It was the greatest fighter he had ever kicked into the air."

"Dear Harry——" . . . . . . *by George Swift* 26
Letters of an Air Student to his Friend.

Crash Courage . . . . . . *by Orlando Rigoni* 28
"The earth became a big saucer that was whirling madly. He laughed—a grim, hard laugh. He'd show them how to crash a ship right!"

5 Articles:

Getting Into Aviation
by Clyde Pangborn and Lieut. W. M. Wood 16
The third article of a series which answers all your questions about opportunities in the air.

Modern Motors . *by Arch Whitehouse and A. N. Troshkin* 24
The fourth article in a valuable technical series—Diesel engines.

The Automobile Engine Takes to the Air . *by Frank Tinsley* 32
The story of the plane on the cover, with specifications.

Early and Strange Conceptions of Flight
by Lieut.-Com. George O. Noville 34
Which starts off like a "Flying Dragon."

Trick Photography . . . . . . *by Henry Clark* 36
Outlining a new and fascinating hobby for Air Trails readers.

8 Features:

This Winged World 4
News photos of airplanes, air events, airmen.

Air Progress 7
The current news review of aviation.

The Flier's Dictionary . . . . . *by C. B. Colby* 15
The twentieth lesson in the technical terminology of the air.

Split Second Action 19
Aerial adventures that come only once in a lifetime.

Control Development 23
A pictorial lesson in basic principles.

Pictorial History of Man in the Air 27
The early days of powered flight.

Air Trails Gallery 31
Photographic studies of new planes.

Cross Winds 37
The Air Trails Aviation Crossword Puzzle page.

2 Departments:

What's Your Question? . . *Conducted by Clyde Pangborn* 35
A page of expert information on technical questions for Air Trails readers.

Air Adventurers Club . . *Conducted by Albert J. Carlson* 38
The first Honor Roll of new ratings is in this issue!

14 Model Building Items:

The Model Shop 40
Model Contents are listed on a separate contents page—Page 40.

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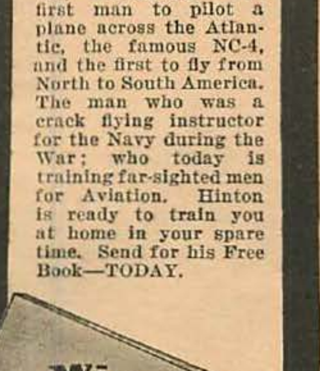

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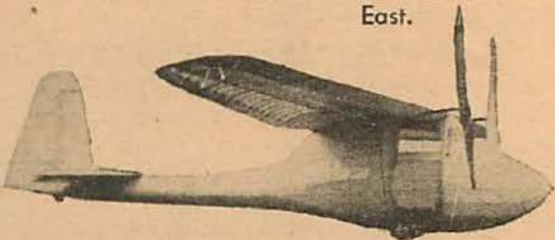
This Winged World

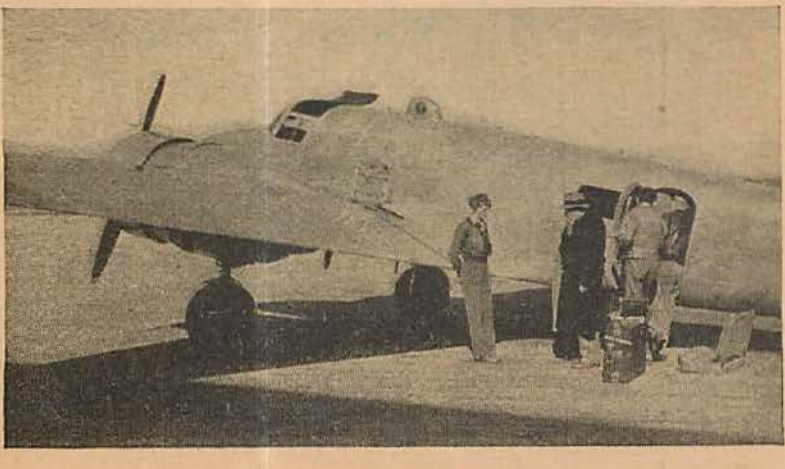
China Clipper, at rest on the sunlighted Pacific and glimpsed through tropical palms, suggests all that the Pan-American passenger enjoys when traveling the air lanes in Southern waters.

Martin bombers in flight to Miami from Langley Field, Virginia, on the first of the two-stage hop to the Panama Canal. Each plane, carrying eight men, is equipped with complete jungle kits.

The Lindberghs after their arrival at Rome, from England. Colonel Lindbergh's custom-built Miles "Mohawk" is carrying them on their extended flight to the East.



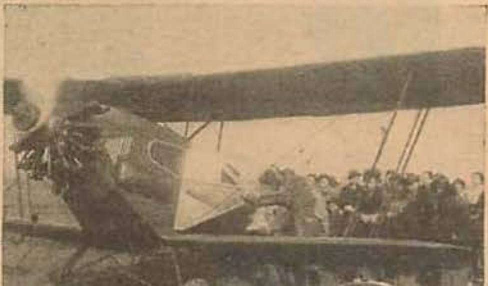
Foot-powered Italian plane is driven by pedals and has actually flown a few hundred feet. It has been entered in competition for 100,000-lire prize offered for the solution of man-powered flight.



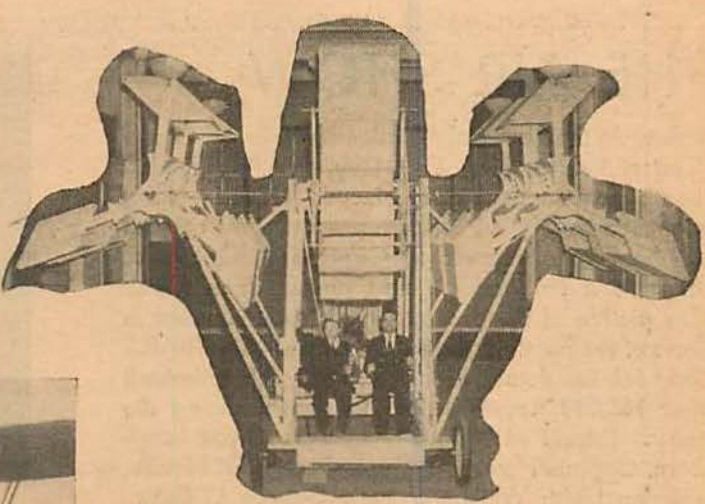
Amelia Earhart's flying laboratory, a special Lockheed Electra, before the recent California-New York "business trip."

同四の日本代表公
集敵中橿由子

Mass demonstration of the Boys' Airplane Association of Japan indicates the popularity of the hobby throughout the world.

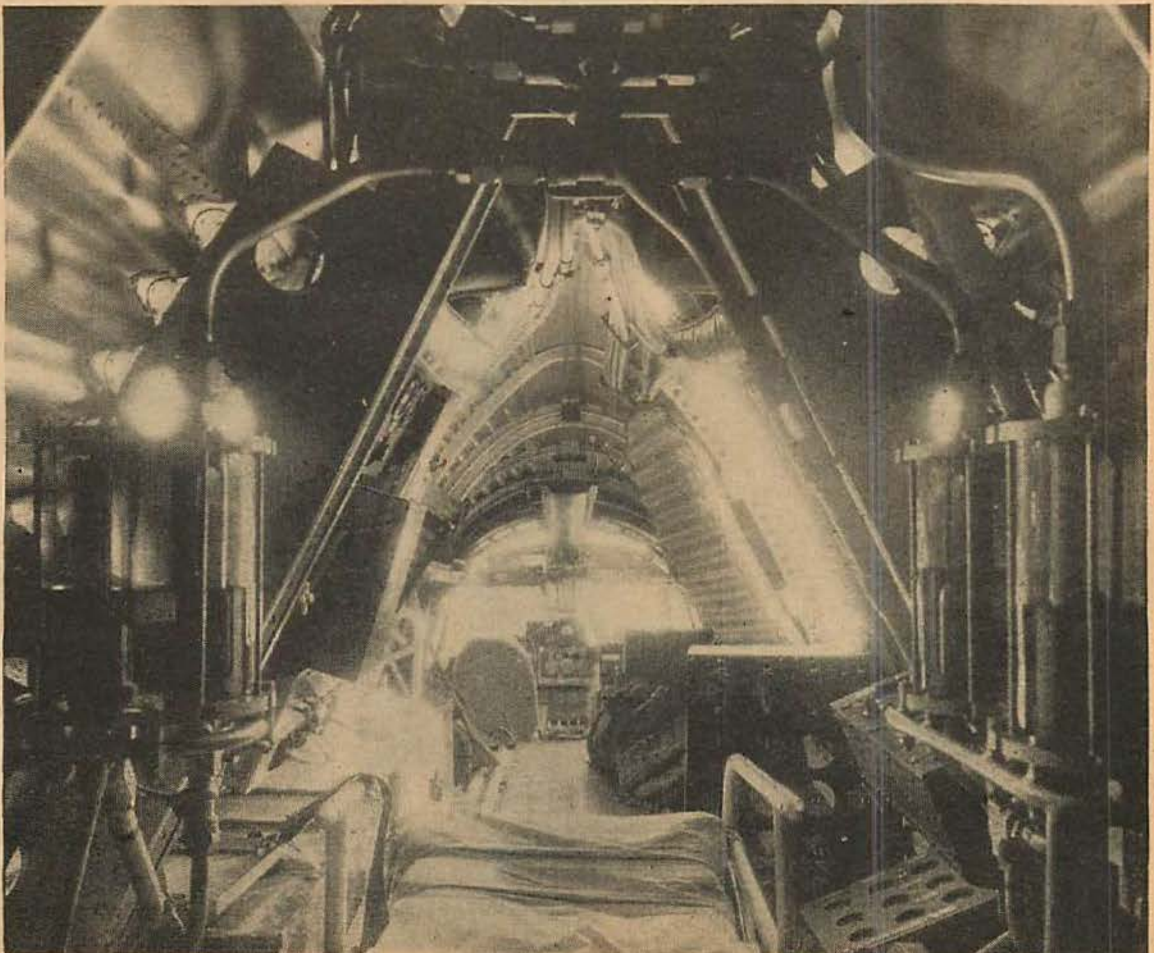


Right: Air Taxi in Japan is popular with the ladies—it is piloted by a woman.



"Aerial Phantom," newly invented plane, has no wings, tail, or propeller. It is to be operated on the turbine principle, claimed to lift 50 pounds per horse power.

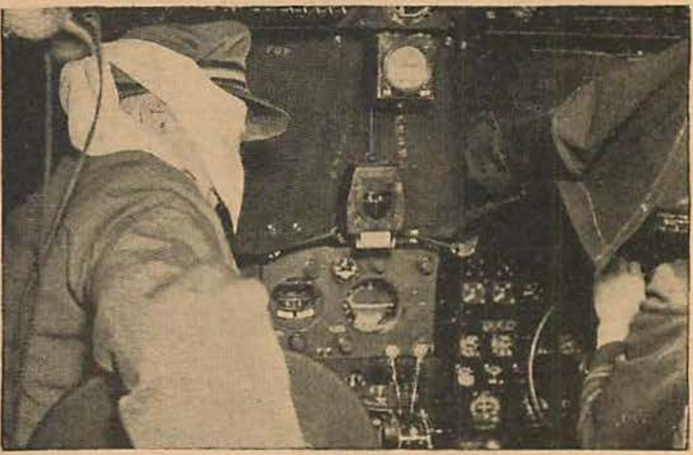
Right: Douglas DF—fourteen-ton flying boat on which Russia holds an option, carries 32 passengers, 200 m.p.h. at 6,000 feet.



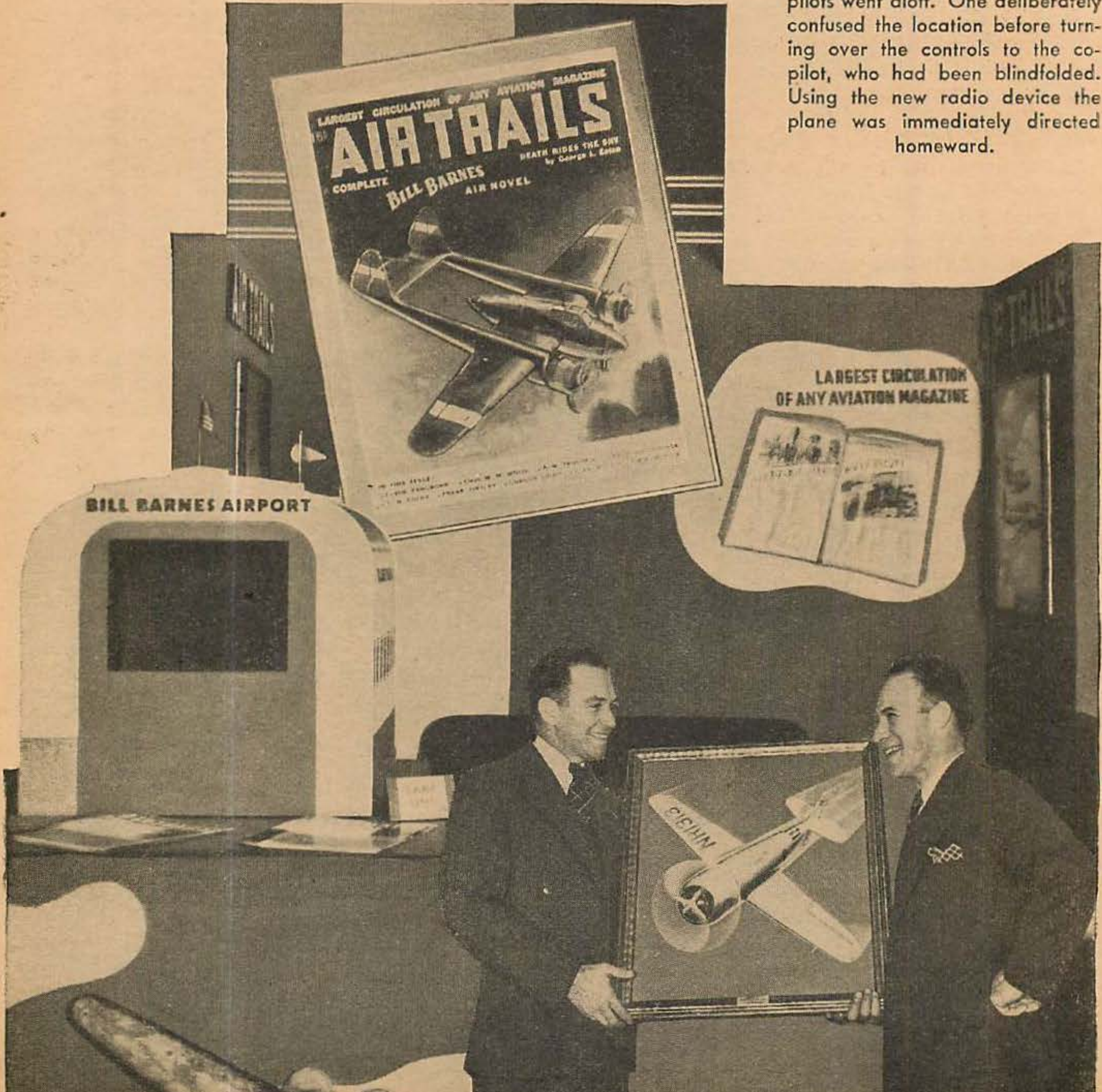
The upper deck of a Martin-built, Pan-American clipper looking forward to the pilot's cabin, shows the engineer's room in the foreground and the radio room between.

THE AIR SHOW

Below: At the National Aviation Show in the Grand Central Palace, New York City, the AIR TRAILS booth commanded a continuous crowd. Wing Commander Clyde Pangborn presented the original of the February cover to Captain Frank Hawks, because it featured his new plane "Time Flies." The picture of the presentation is superimposed in front of the booth so that all readers of AIR TRAILS may see the details of the display. It is estimated that 165,000 people visited the booth during the show. Present at various times were Clyde Pangborn, Captain Hawks, Lt. Com. George O. Noville, Gordon Light, William Winter, George L. Eaton, Frank Tinsley, Commander Carlson, and many other prominent aviation figures.



To demonstrate new "pigeon instinct" homing device, two T. W. A. pilots went aloft. One deliberately confused the location before turning over the controls to the co-pilot, who had been blindfolded. Using the new radio device the plane was immediately directed homeward.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BILL BARNES AIRPORT

AIR PROGRESS

A Summary of Aviation News

Official photo, U. S. Navy

AIR FORCES

FLEET-LANDING exercises of a secret nature will be held this month off southern California. Army, navy, and marine airmen will take part, and considerable precaution will be taken to make certain that all details of the so-called Operation No. 3 will be carried out as efficiently as possible. Owing to the length of coast line to be protected by the United States, defense officials intend to make this one of the most important strategic exercises for the three services.

The war in Spain continues to provide much of interest for followers of military aviation all over the world. While sporadic bombing makes up the bulk of the action, a few air battles have taken place recently. Two insurgent planes were shot down Feb. 13, 1937, while attempting to bomb along the Madrid-Valencia highway. It is believed that the Loyalist airmen are obtaining better fighting craft from Russian factories and are now able to put up a better showing against the fast German Heinkels and Italian Fiats which are being used by the Rebels.

Eight army bombers of the 96th Aero Squadron recently completed a four-thousand-mile round-trip flight between Langley Field, Va., and France Field in the Canal Zone. Fifty-seven planes of the 27th Squadron, the 1st Bombardment Squadron, and the 8th Squadron, as well as nine special transport planes from Barksdale Field, took part in the annual mid-winter maneuvers at Mouth Clements, Mich., and were inspected by Colonel W. A. Frank of Mitchel Field, N. Y. The maneuvers included aerial-gunnery practice, bombing and tactical maneuvers. The public was treated to many forms of mass flights.

During the maneuvers, Colonel Frank started an investigation into the reason for faulty landing gear found on several Martin D-10 bombers. One of the retractable landing gears fouled when a Martin, piloted by Lieutenant David P. Laubach, was trying to get in. It was impossible to get the wheels down, but Laubach brought the machine in safely and saved the lives of his crew of three.

Owing to the splendid coöperation of the Royal Air Force Fleet Air Arm, the "attacking" Blue Fleet was forced to give up its attempt to make a successful landing at Singapore. This occurred during the recent "war games" in the Far East. The raiding "Blue" destroyers were continually "attacked" by the defense air and under-water fleet and had to withdraw after suffering "considerable losses." A new "Battle Junior" light bomber has been built by the British Fairey Co. for the Royal Air Force, which British air writers claim to be the fastest single-engined bomber in the world. It is actually a small edition of the Battle. Britain is now testing a French Dewoitine D.510 fitted with a Hispano-Suiza "cannon" engine. While refueling a large bomber in Mesopotamia, British service men have to figure on the loss of at least five gallons of fuel due to evaporation. They are now working on a new refueling device which will trap the vapor and suck it back into the main tank in its original form.

European visitors to Berlin were recently treated to a display of German anti-aircraft gunnery. All were astonished at the remarkable accuracy of the German gunners. "Berlin has not much to fear from the air," one British observer admitted.

Canada has allotted $11,750,000 for the strengthening of the Royal Canadian Air Force. Many new officers will be accepted, and five hundred airmen mechanics will be required at once. More than one hundred new machines will be purchased immediately.

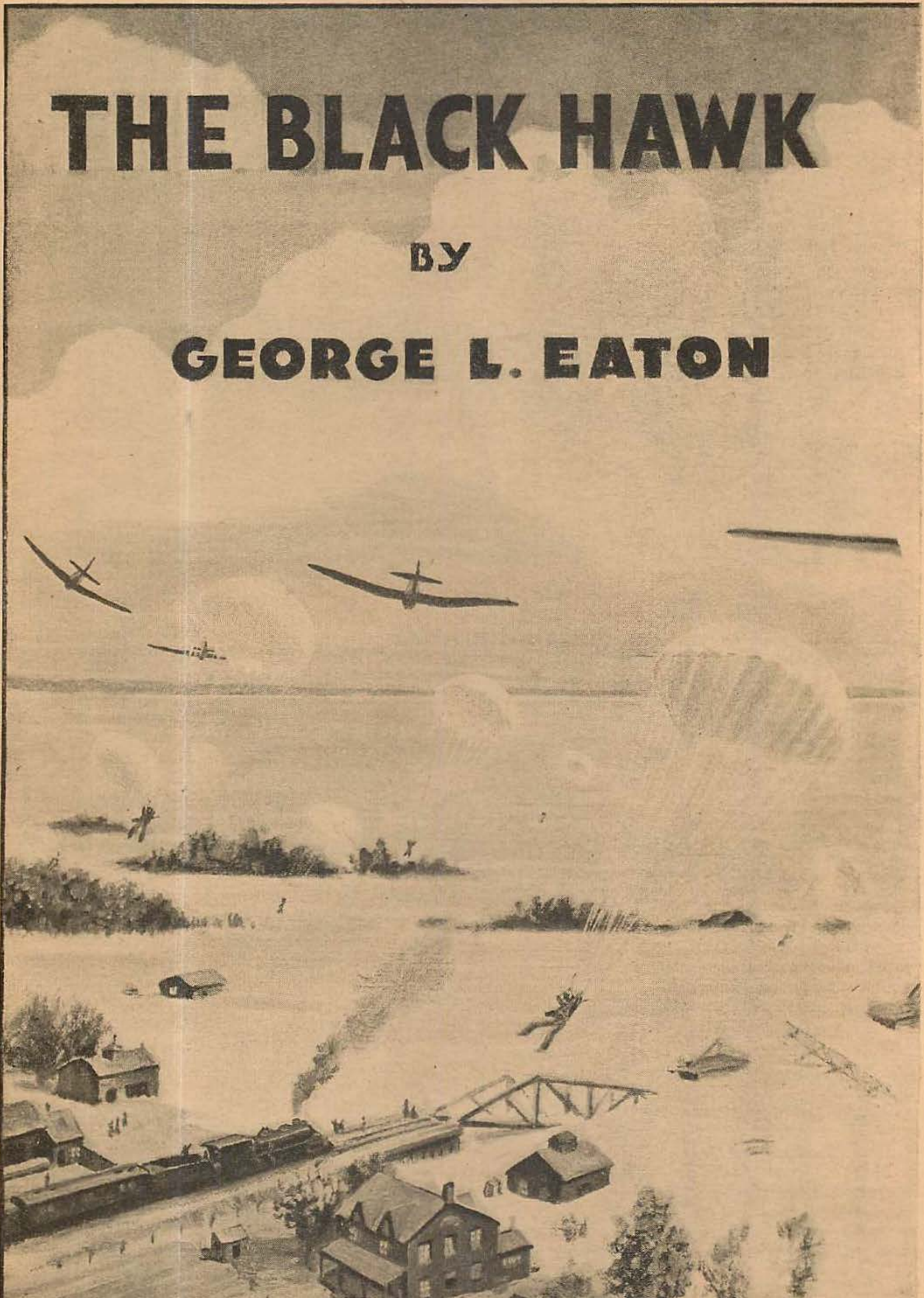
A large number of Vought V142 scout bombers, purchased by the Argentine Government,

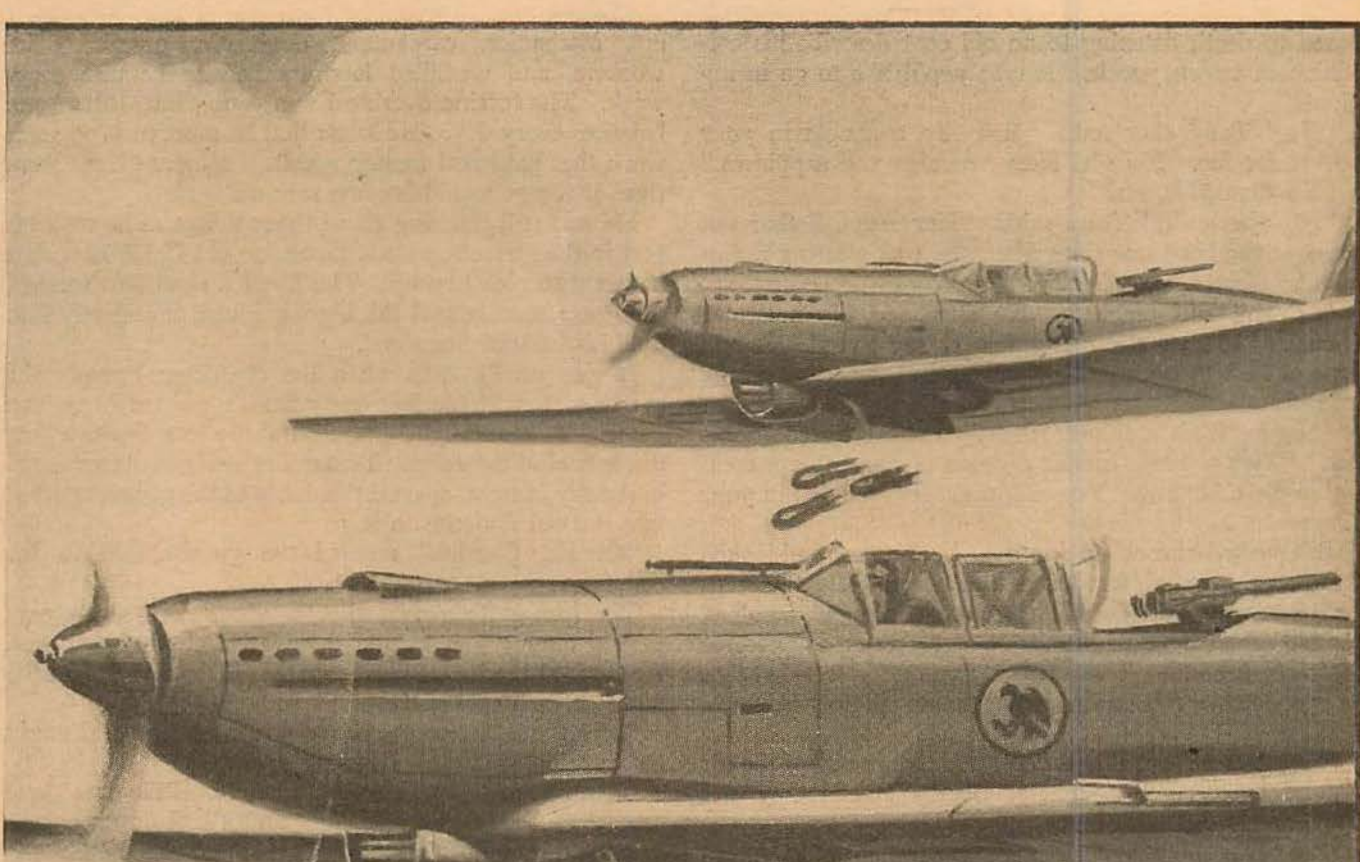
(Turn to page 81)

THE BLACK HAWK

BY

GEORGE L. EATON





A NEW BILL BARNES AIR NOVEL

BILL BARNES shouted "O. K.!" above the idled roar of the two Barnes Diesels in the nose of the Silver Lancer. "I'll be back between ten and eleven. Shore leave for any one who wants it to-night, Scotty. Shorty and Red are down in Washington making a check on that aerial survey of the national parks. If they come in to-night tell 'em to wait up for me."

"Right, boy," said "Scotty" MacCloskey, major-domo and chief technician at Barnes Field. "It's a nice thing you're doing—having dinner with your father's old friend."

Bill glared at him and eased his powerful frame into the front cockpit of the gleaming Lancer.

"Time is about the only thing I'll have, if we don't get some work around here before long," he shouted back at Scotty, as he jazzed the three thousand horses in the twin Diesels. He slid back the bulletproof glass hatch above his head and stuck his tan brogues into the rudder stirrups. He flicked the radio key on the instrument panel and spoke into the black mike hung before his lips.

"How's it, Tony?" he asked Tony Lamport, head radio operator and dispatcher on Barnes Field.

"All clear, Bill," Tony said. "Wind E. S. E. Be a good boy, Bill."

"Phooey to you!" Bill exploded. "I expect to be bored to death listening to an old coot describe his collection of crown jewels. Maybe you'd like to go in my place?"

"No." Tony chuckled. "Just slip a couple in your pocket for me. My girl likes emeralds and sapphires."

"No diamonds, eh?"

"No diamonds," Tony said. "Her Aunt Esther got hit over the head one time when she was wearing a diamond. She's against 'em."

"O. K." Bill laughed. He shrugged his muscular shoulders to ease the discomfort of the tweed suit and topcoat he was not used to wearing in the cockpit of the Lancer.

"Hey! Wait a minute, Bill!" Tony shouted in his ear. "Two of those carrier pigeons of Sandy's are coming in for a landing. You might get 'em tangled in your props."

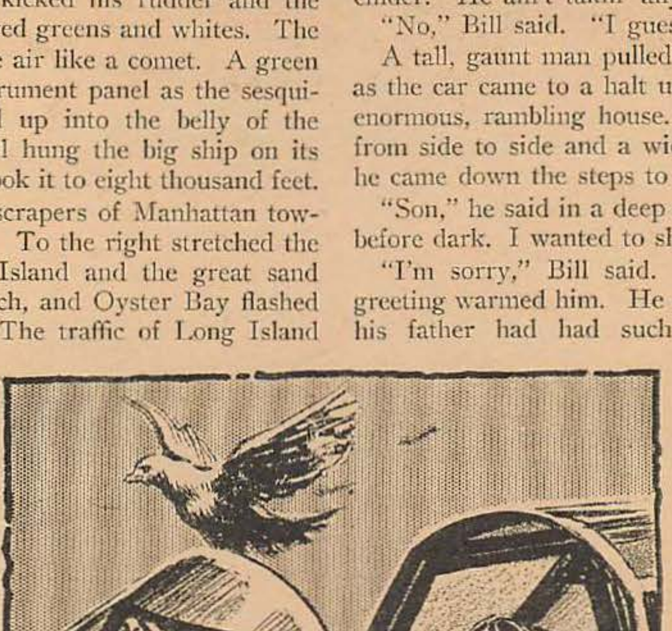
Bill pushed himself up out of his bucket seat and looked back over his shoulder across the apron. On the steps of the administration building young "Sandy" Sanders, the kid ace of his little squadron, was waiting to welcome his pigeons home. There was a grin on his freckled face as he watched his latest hobby come gliding in for a landing.

"Tell him to keep those dog-gone things out of the air around here!" Bill roared at Scotty MacCloskey and threw off his wheel brakes.

The big sesquiplane screamed as Bill poured soup into the engines. Where the main runway converged with a number of smaller ones he kicked his rudder and the world became a place of blurred greens and whites. The silver bullet skimmed into the air like a comet. A green light came to life on the instrument panel as the sesquiplane landing gear snuggled up into the belly of the fuselage and the wings. Bill hung the big ship on its two three-bladed props and took it to eight thousand feet.

Far off to the left the skyscrapers of Manhattan towered into the hazy afternoon. To the right stretched the long, rolling hills of Long Island and the great sand dunes. Jericho, East Norwich, and Oyster Bay flashed below the Lancer's wings. The traffic of Long Island Sound chugged east and west, north and south. The great ball of fire that was the sun crept toward its bed in the hills of New Jersey. Lights began to flicker on in the homes along the Connecticut shore, as Bill slapped the main float and wing-tip pontoons on the water off Shippan Point and taxied toward the landing ramp.

During that short hop from Barnes Field, Bill had been thinking about just one thing: the lack of activity on his airport during the past two months. Business had been at a standstill. His little squadron of fliers were becoming both jumpy and bored. The salaries of the small army of grease monkeys, sheet-metal workers, mechanics, carpenters, engineers, guards, office workers, and unskilled laborers had to be met every week. The terrific overhead was eating into Bill's bank balances every day. He knew that he must turn up some work that paid real money within a comparatively short time or things would become serious.


Making sure the little metal tag was fastened securely on the leg of the carrier, Sandy let it free——

He was still thinking about those things as he took his seat in the gleaming, black limousine old Caleb Barnabas had sent to pick him up. The liveried chauffeur meshed the gears silently and the big car glided noiselessly into the hills back of Stamford.

It was nearly dark when the chauffeur brought the car to a stop fifteen feet away from a pair of huge iron gates. A searchlight played on the car from a low tower behind the gates. Two uniformed guards appeared in the ray of light, opened the doors of the car and peered into it, then underneath it.

"O. K., Charlie," one of the guards said to the chauffeur.

The iron gates swung silently open. Bill saw a man with a tommy gun behind the searchlight in the tower. He noticed the high wire fence that disappeared into the night on each side of the gateway.

"Mr. Barnabas seems afraid a strange squirrel might get into his grounds," Bill said dryly.

"It's his jools," the chauffeur said. "He has three men at each gate day and night and a half dozen patrolling the grounds. The wire fence all around the place is charged with enough electricity to burn a man to a cinder. He ain't takin' any chances any more."

"No," Bill said. "I guess he isn't."

A tall, gaunt man pulled himself out of a porch chair as the car came to a halt under the porte-cochère of the enormous, rambling house. He shook his leonine head from side to side and a wide smile wreathed his lips as he came down the steps to shake Bill's hand.

"Son," he said in a deep voice, "I told you to get here before dark. I wanted to show you around the place."

"I'm sorry," Bill said. The sincerity of Barnabas' greeting warmed him. He could readily understand why his father had had such a great affection for the "swashbuckling old pirate" as the press had called him. "I was tied up with things I couldn't very well leave. Don't we still have time to look around before dinner?"

"Yes," Barnabas said. "I'll get a flashlight."

He guided Bill through the huge, glass-inclosed conservatory where he bred and crossed a hundred varieties of orchids. From there they went through a little theater that was complete in every detail, including a pipe organ. A few hundred feet away stood a log cabin with a bar twenty feet in length. A Negro bartender mixed Caleb Barnabas an old-fashioned cocktail, while Bill sipped orange juice.

With a half-mad cry, Henderson threw himself back into his bucket seat. He leveled the Snorter off and tried to give it the gun. But the nose began to fall——

"You don't drink at all, eh?" he said to Bill.

"Can't afford it in my business," Bill said. "The day of the drinking pilot has passed. Anyway, they drank enough during the War to take care of three generations."

"It's too bad you weren't old enough to be a Wartime pilot, Bill. You'd have been a great ace."

"Yes," Bill said, "and I might be dead. I have a kid pilot, Sandy Sanders, who is like a son to me. I hope he never has to go to war."

His eyes flitted over the interior of the log cabin. It was decorated in exact imitation of the old-time Western saloon of frontier days. It was easy to imagine a group of long-haired, booted men with six-guns strapped around their waists standing over the faro table in the center of the room. For an instant Bill could smell the smoke of battle, as one of the figures pulled a gun and shot the chimney of one of the flickering oil lights.

"I suppose you have some great parties here," Bill said.

"I do," Barnabas replied. "You know I made my money in copper in the days of the old West. I come here and sit alone and see a hundred, a thousand men I knew march before my eyes."

"I suppose you have lots of company, too, at times?"

"No," Barnabas snapped. "You are the only guest I've had here for purely social reasons in over a year. Every one who used to come wanted something. Some of them were trying to figure a way to get into the place and rob me of my jewels."

The old man's face softened for a moment as he spoke of his collection of jewels—but as quickly hardened again. He turned sharp eyes on Bill. "You don't want anything, do you?" he asked.

"No." Bill laughed. "I don't want anything. But I do want to see your collection."

"You'll see it, son," Barnabas said. He finished his drink, nodded good night to the lonesome bartender and they went toward the house.

It was probably only instinct that made Bill stop and listen as he heard a fourteen-cylinder Meredith airplane engine thundering overhead.

"He's circling overhead," Bill said.

The old man tipped back his head and peered upward at the dim outline of the low-winged monoplane against the night sky. Bill pointed out the green-and-red running lights of the ship.

"He better stay up there," Barnabas said, grimly. "We're prepared to take care of any kind of unexpected visitors around here. There is a private airport near by. It's on my land."

"I noticed that," Bill answered. He decided that the old man was undoubtedly a little off balance. He had worried so much about his precious jewels that it had become a phobia. He was devoting his life to protecting them.

Bill recalled that all of the precious stones had belonged to Barnabas' wife before her death. She had been a famous stage beauty in her day. When she grew older and her beauty passed, she used her priceless collection of baubles to attract attention to herself, attention she could not be happy without. When she died, only the jewels remained alive. The old man had come to regard them as a living part of her. Bill remembered now that he had heard stories about the old man spreading them out on a table and talking to them as he might have talked to her. The thought sent cold shivers up his spine.

The cheery lights inside the enormous, rambling house drove the momentary feeling of apprehension from his mind. But he shivered again as a cold, fall wind whipped down through the sighing pine trees around the house.

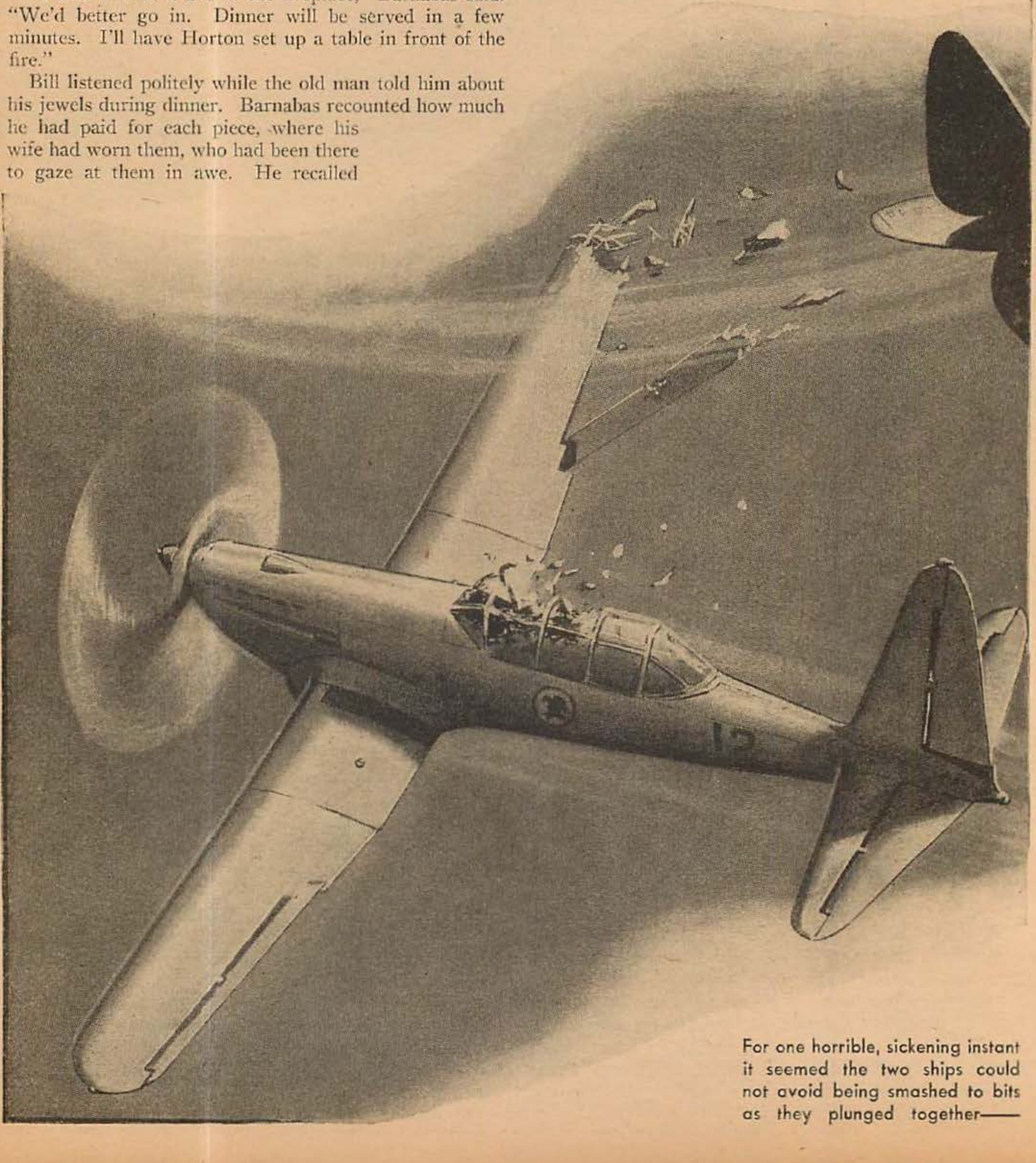
"There will be a fire in the fireplace," Barnabas said. "We'd better go in. Dinner will be served in a few minutes. I'll have Horton set up a table in front of the fire."

Bill listened politely while the old man told him about his jewels during dinner. Barnabas recounted how much he had paid for each piece, where his wife had worn them, who had been there to gaze at them in awe. He recalled conversations he and his wife had had when they returned home after she had worn them. He remembered the dozen attempts that had been made to rob her and told Bill about the attempts to rob his burglarproof vault since her death.

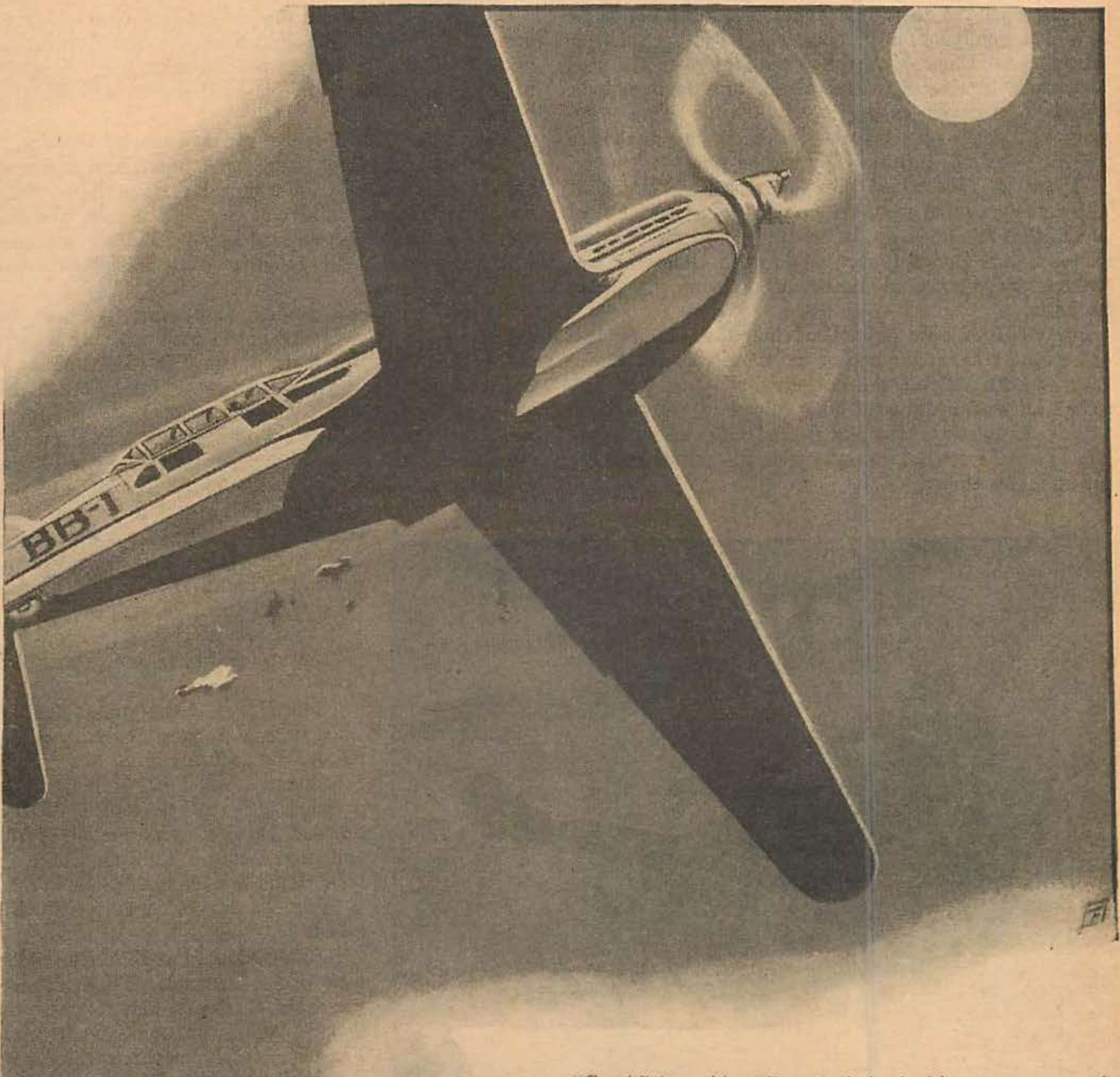
"But," he finished, "the place is impregnable now. Burglars could no more get in here than the Germans could get into Verdun. I——" He stopped speaking as he saw Bill cock his head on one side and listen to the increasing roar of an airplane engine overhead.

"That baby is low," Bill said. "He's hedge-hopping in an autogiro."

"He'll get rock salt in his pants if he hedge-hops around here," old Barnabas growled, and dismissed the plane from his mind. "I paid two hundred and twenty



For one horrible, sickening instant it seemed the two ships could not avoid being smashed to bits as they plunged together——



thousand dollars for that pear-shaped diamond," he went on. "Old Brixley's wife was trying to buy it. He bid the price up. But I topped him. His wife wouldn't speak to Mrs. Barnabas the next time they met."

Bill shrugged his shoulders impatiently. He wondered just why he had let himself in for such an evening. He was wasting valuable time listening to this old eccentric babble on and on about a bunch of baubles. What if they were worth millions? What difference did it make? Who cared what Mrs. Barnabas said to Mrs. Brixley?

"I'm afraid I can't stand it any longer," he said. "You've got me sitting on the edge of my chair."

Barnabas rubbed his hands together and beamed. "Good," he said. "But don't be looking at your watch. You'll forget all about time when I spread my collection out before you. I've spent a whole day over them, time after time. We'll go upstairs to the vault."

He led the way up two flights of stairs. At the top of the second flight the whole character of the house changed. The stuffy Victorian furniture on the first two floors became Spanish. Off the landing was a huge steel grille that opened into a high Spanish room designed as a patio. The ceiling was the color of the sky of old Spain. A balcony was cut into the side of the wall.

"Don't touch anything," old Barnabas said. "There is a concealed electric switch that turns off the current in the steel door. I——"

Bill whirled as he heard the gasp that came from old Barnabas. He grabbed at the man's arm to steady him as he turned with tortured eyes and trembling lips.

"S-s-s-s——" came from Barnabas' lips as he fitted a key into the steel grille. He was trying to speak, but no words came from his lips. Only a series of sounds that were incoherent.

He would have fallen if Bill hadn't grabbed him when he threw open the door. He would have fallen beside the body that was lying on the floor with its throat slit from ear to ear. Blood was still spreading over the rug. The man's legs were twisted under him as though he had been on his knees begging for his life when something had slashed his throat. He had fallen backward and his head lolled grotesquely to one side.

"Francis!" Barnabas' lips mumbled. "Francis!" Then his eyes lifted from the horrible thing on the floor and Bill felt his body go slack. Bill picked him up, laid him on a davenport and shouted down the stairs. When he heard steps ascending he swung back into the Spanish room.

For the first time he noticed that the window that was swung wide at the end of the room was not a window. At first glance the curtains and glass had prevented his seeing the steel door behind it. He stepped quickly across the room and peered into the wall safe. Papers were scattered around inside it. Aside from the papers it was empty.

When he signaled with a flashlight, the autogiro flew over the house, dropped a ladder. The thief swung up on it——

Bill whirled as two of the hardest-looking men he had ever seen came charging into the room with drawn guns in their hands. Their eyes popped as they saw the gray-haired man on the floor, his head soaked with his own blood.

"All right. Talk!" one of the men snarled at Bill.

"Get some smelling salts, some water, and a slug of brandy or whisky," Bill snapped back at him. "Mr. Barnabas fainted. His heart——" The man who had snarled at him disappeared down the stairs as the man who had served them at dinner stuck a frightened face around the corner.

"Water!" Bill said to him and began to loosen the old man's clothing. He dropped a thumb on his pulse and held it there for a moment. The old man's heart was beating steadily and strongly. Bill looked at his white, gaunt face and shook his head.

Bill held the smelling salts under his nose for a moment, then lifted his head and put the whisky to his lips as his eyes flickered open and closed. Barnabas choked on the whisky for a second, then opened his eyes and kept them open. They fastened on the imitation window across the room. He pointed a trembling finger at it.

"My wife's jewels?" he asked.

"I'm afraid they're gone," Bill said. "I——"

"Gone!" one of the guards snarled. "It's time you began to talk, young fellow," he said to Bill.

"Shut up, Williams!" old Barnabas growled. "Go call the police. This is murder. Bill, get every one out of here and keep them out until the police arrive. This is a horrible shock to me."

"Was he an old employee?" Bill asked.

Barnabas looked at Bill in bewilderment for a moment. Then his eyes wandered to the twisted form on the floor. "Oh," he said, "you mean Francis. Yes, he has been with me for twenty-five years." His eyes wandered away and settled on the vault again.

Bill turned away, sickened at the avarice of the old man. He began to circle the room, looking for anything that might be a clue. A moment later his eyes fastened on the figure of a bird stamped on the wall above the door of the vault. It was about three inches in height and had the head and short, rounded wings of a hawk. He reached up and touched it, because it looked as though the ink was still wet. The ink came off on his finger.

"Did you put that impression of a black hawk there on the wall?" Bill asked old Barnabas.

Barnabas' eyes grew wide as he stared. "It has been stamped there?" he asked.

Bill nodded his head and showed Barnabas the end of his finger. "The ink isn't dry," he said. *(Turn to page 64)*

THE FLIER'S DICTIONARY

The twentieth lesson in the technical terminology of the air. Save your files!

INSIGNIA OF THE WORLD'S AIR SERVICES

1 ARGENTINA
2 BELGIUM
3 BOLIVIA
4 BRAZIL
5 FRANCE
6 ENGLAND
7 GREECE
8 PERSIA
9 RUMANIA
10 SOUTH AFRICA
11 SPAIN
12 DENMARK
13 EGYPT
14 CHILE
15 HOLLAND
16 SIAM
17 U. S. NAVY
18 U. S. ARMY
19 SWEDEN
20 CHINA
21 YUGOSLAVIA
22 CZECHO-SLOVAKIA
23 PARAGUAY
24 LATVIA
25 JAPAN
26 URUGUAY
27 LITHUANIA
28 NORWAY
29 POLAND
30 PORTUGAL
31 SOVIET RUSSIA
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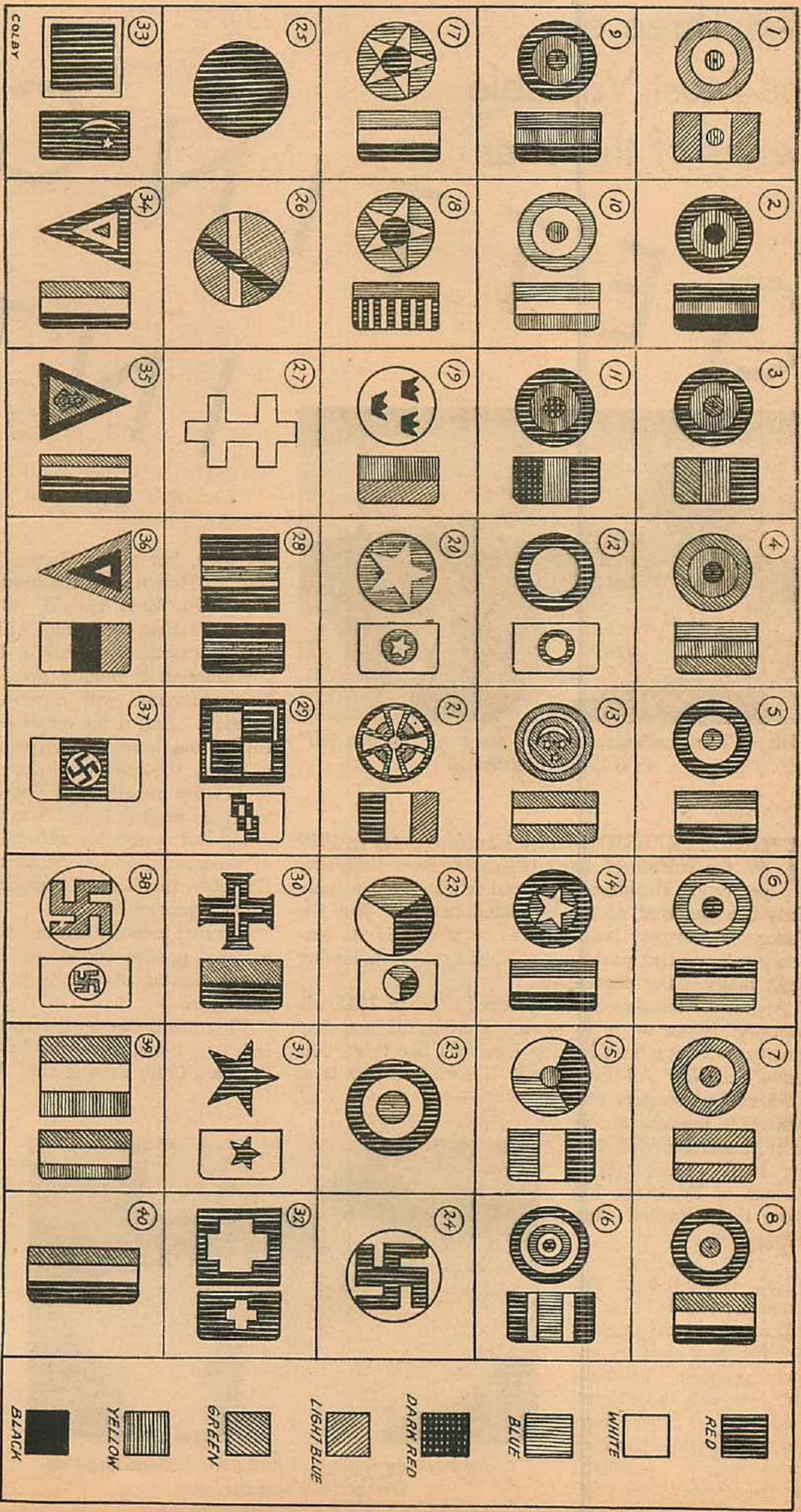
35 IRAQ
36 ESTONIA
37 GERMANY
38 FINLAND
39 IRISH FREE STATE
40 ITALY



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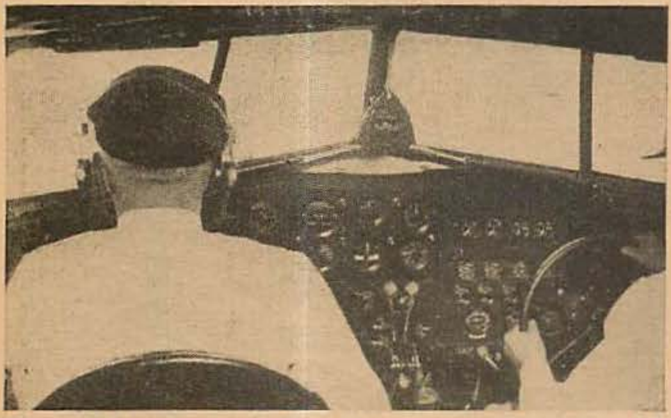
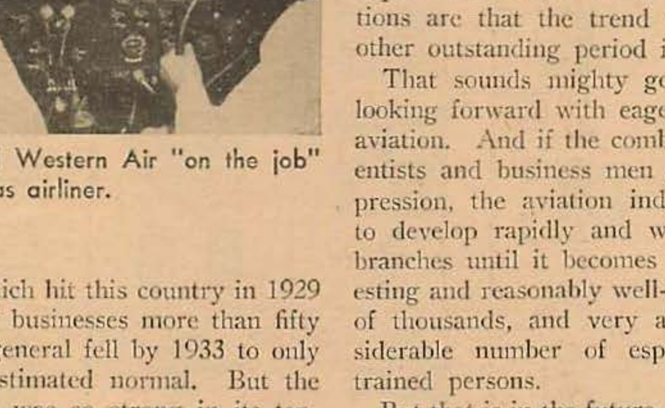
GETTING INTO



Pilots of Transcontinental and Western Air "on the job" in a Douglas airliner.

THE DEPRESSION which hit this country in 1929 cut the volume of many businesses more than fifty per cent. Business in general fell by 1933 to only sixty-five per cent of the estimated normal. But the young air-transport business was so strong in its tendency to grow that passenger mileage kept on increasing right through the depression.

And when the depression loosened a bit in 1935, air transport began to go to town. During the past few months you have been reading headlines like this: "Air Lines Set New All-time Traffic Record." More than 1,000,000 passengers and 8,000,000 pounds of air express were carried during 1936. That means volume of business has more than doubled since 1934.



A meteorology student of Parks Air College drawing up a daily weather map.

Recently Mr. Eugene L. Vidal, Director of Air Commerce, said: "The excellent record of progress for the past year is the more gratifying because the growth has been sound. . . . We have seen normal, healthy growth . . . which represents not only a present gain, but also a firmer foundation for the future. . . . Nowhere in the industry is there evidence that a peak has been reached. On the contrary, all indications are that the trend will continue upward to another outstanding period in 1937."

That sounds mighty good for young men who are looking forward with eagerness and hope to careers in aviation. And if the combined brains of statesmen, scientists and business men can prevent another bad depression, the aviation industry will probably continue to develop rapidly and without interruption in all its branches until it becomes a vast industry giving interesting and reasonably well-paid employment to hundreds of thousands, and very attractive positions to a considerable number of especially qualified and highly trained persons.

But that is in the future. Right now we are interested in what present conditions and prospects mean to the young person anxious to get into scheduled air transportation.

First of all you must remember that the air-transport industry, though growing fast, is still small. A survey in June, 1936, showed that the air lines altogether had only about 9,000 employees. In contrast, the railroads of the country normally employ about 1,700,000 persons. The air lines have been hiring additional employees at the rate of about 2,000 a year.

Add to that the new employees required for replacements and the total number hired each year will still be relatively small. Opportunity for people with specialized training in many other occupations is much greater, especially just now in the

AVIATION

by CLYDE PANGBORN
and LT. W. M. WOOD

Students of the Boeing School of Aeronautics at work in the engine shop.

general post-depression expansion.

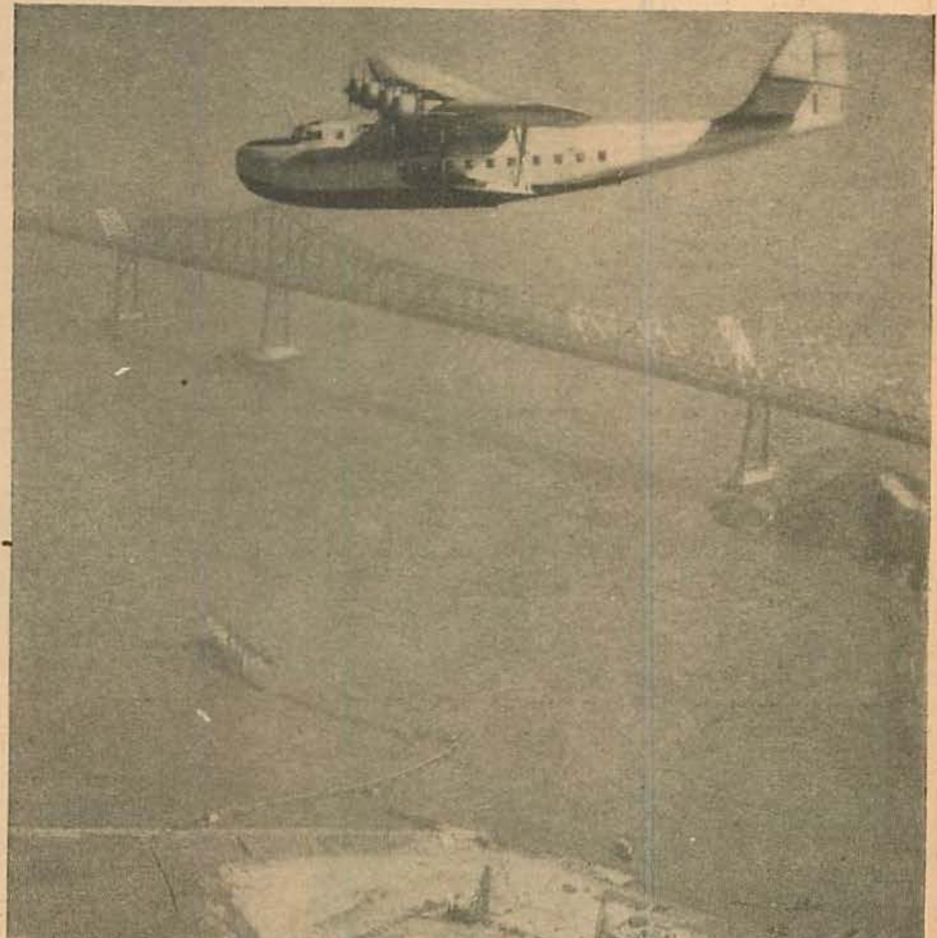
Columbia University reports that the demand for college-trained specialists in many lines is greater, and salaries offered higher, than in the boom times of the 1920s. Skilled workmen in the trades are also needed.

For example, the president of the National Association of Photo Lithographers said recently that 10,000 more skilled technicians could be used in that industry alone.

Many of the present set of young men who want careers in aviation are not going to find room, and some perhaps will pass up chances to get into other lines that would pay them good money and enable them more quickly to join the growing ranks of those who fly for fun. And in that connection we have observed that people who have aviation as a hobby often enjoy it much more than some of those who work at it for a living.

Though the opportunities in aviation are not as numerous as in other industries, to young men of great ability they seem to promise much. The fact that the industry is small at present, but likely to become big means that those who do get in now—if they have a lot on the ball—will have a better-than-ordinary chance to advance to bigger jobs as the industry expands.

However, the greater opportunity, coupled with the special fascination of aviation, means that smart Jack and a lot of his smart brothers are clamoring at the gates. The best aviation schools are rushed with applications for



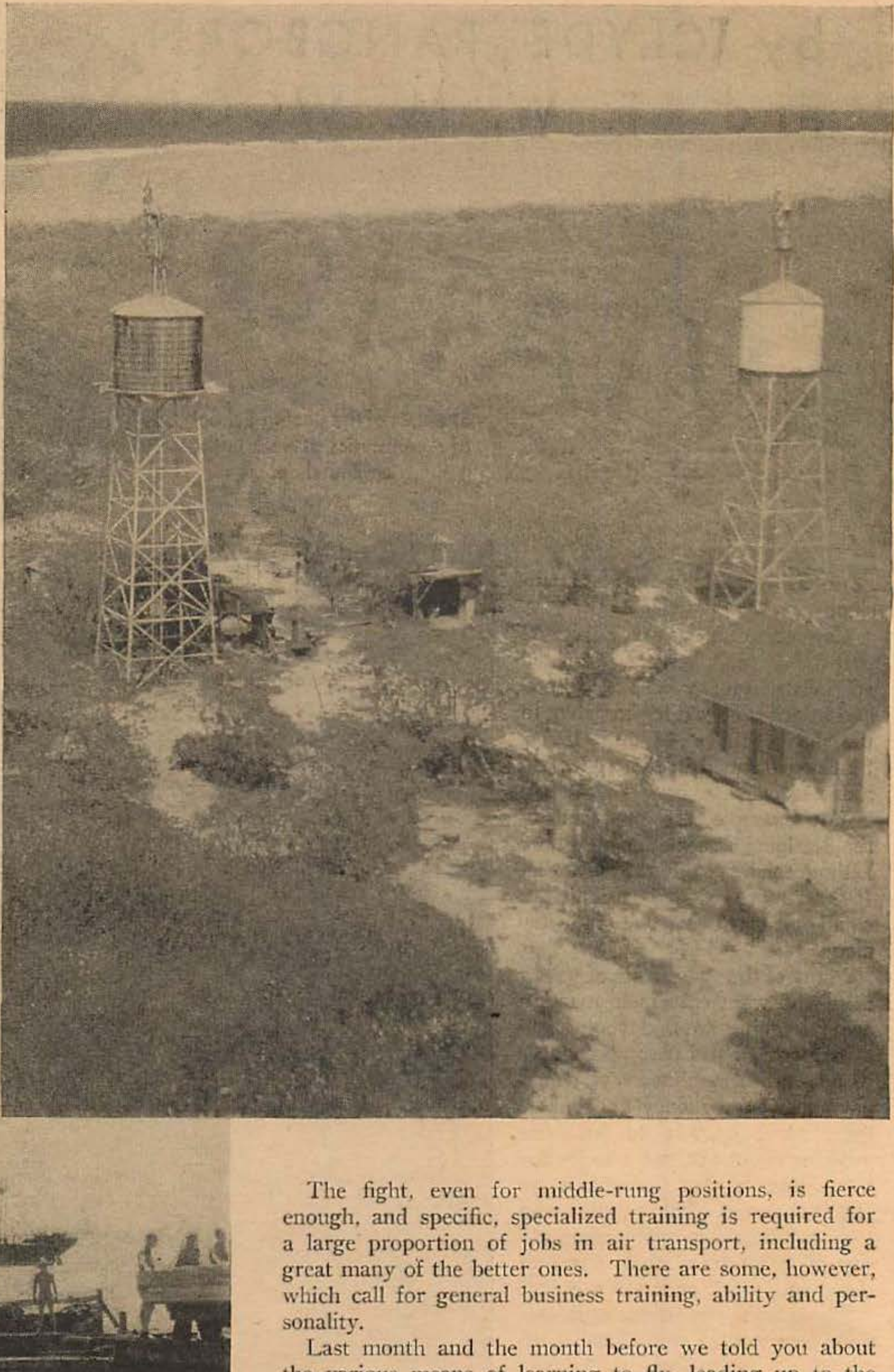
Above: This clipper ship is dependent on hundreds of trained men on the ground as well as on its crew.

Left: One of many airline jobs is the loading of the great transports.

admittance, and they are taking only the best. The first-class schools which maintain close contact and high standing with the big companies try to keep their enrollments down to the point where graduates can be absorbed by the industry.

Other schools, more interested in making money than in serving either the industry or their students, take all comers, give them a smattering of knowledge and experience and turn them loose. Some of these students find work, if they have learned to do even one small job well. And if they are smart and energetic enough to compensate for inadequate training, they find a way to learn, develop and advance.

But it is obvious that the better-prepared men of equal talent have the advantage in the intense competition for promotions. As in every other line, the really good jobs are few compared to the many jobs requiring less breadth and ability.



Above: That there is a place for all in aviation is evidenced by these trained workmen unloading materials for the Pan American base at Wake Island.

Top right: This outpost at Wake Island in mid-Pacific is proof that aviation is not harnessed to the cities.

The fight, even for middle-rung positions, is fierce enough, and specific, specialized training is required for a large proportion of jobs in air transport, including a great many of the better ones. There are some, however, which call for general business training, ability and personality.

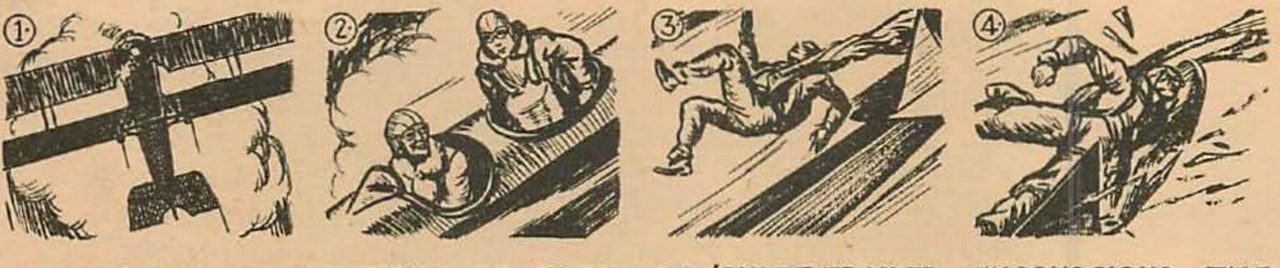
Last month and the month before we told you about the various means of learning to fly, leading up to the point where a man has finished a course of military flying training, or commercial training with special attention to fulfilling the requirements for a beginning job as an air-line pilot.

Lest you get a distorted impression of the part the pilot plays in the complex business of air transportation, let us try now to get a bird's-eye view of the kinds of jobs offered by an air line, and talk about the pilot's job when we come to it.

Let us suppose that you had suddenly become a multimultimillionaire and were going to order yourself an air line just as you would order your breakfast. Great air-transport systems are never built (Turn to page 87)

SPLIT-SECOND ACTION

Hair-breadth escapes, hair-trigger decisions, dangerous moments that come once in a lifetime.

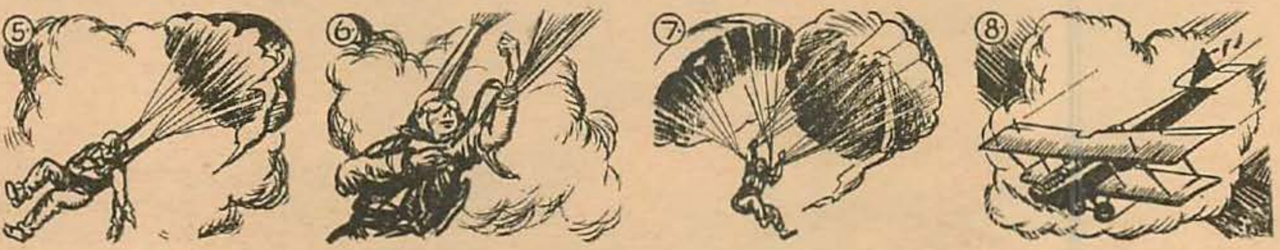


IN AN EFFORT TO BREAK THE ARMY RECORD FOR THE LONGEST PARACHUTE JUMP, SERGTS. MADAN AND BOTTRIELL FLEW TO 20,600 FT. ALTITUDE.

BOTTRIELL, READY TO JUMP, STOOD UP IN THE COCKPIT. THE RIP CORD RING OF HIS PARACHUTE CAUGHT ON THE MACHINE GUN RING.

THE 'CHUTE TRAILED BACK AND JERKED BOTTRIELL OUT OF THE COCKPIT AND SMASHED HIM INTO THE RUDDER. HE WAS KNOCKED

UNCONSCIOUS, THE RUDDER TORN AWAY, A NUMBER OF THE SHROUD LINES BROKEN AND A PANEL OF THE 'CHUTE TORN. WHEN-

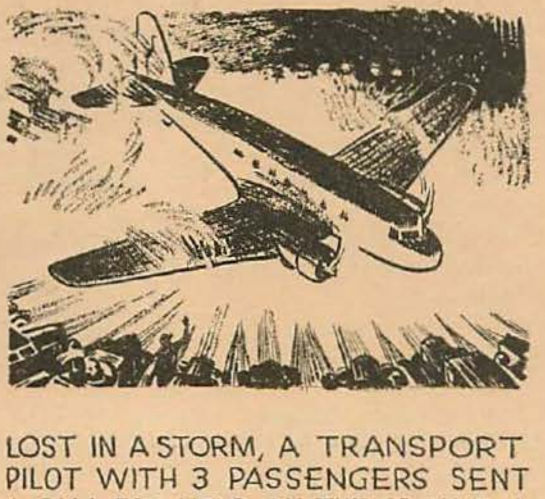


BOTTRIELL REGAINED CONSCIOUSNESS, HE FOUND HIS LEFT ARM USELESS AND BLEEDING. REALIZING HE MIGHT BLEED TO DEATH, HE

LIFTED HIS INJURED ARM AND TWISTED THE SILK SHROUD LINES AROUND IT. SEVERAL TIMES, ON THE WAY DOWN, THE ARM SLIPPED OUT.

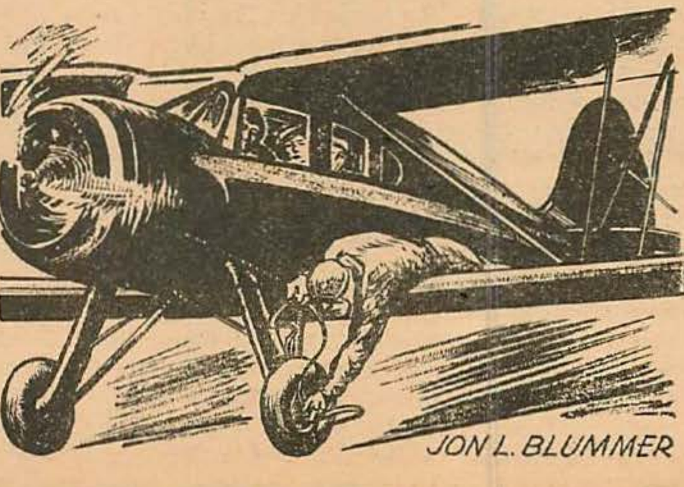
COMING DOWN FAST—WITH THE TORN 'CHUTE BOTTRIELL OPENED THE EMERGENCY 'CHUTE AND LANDED SAFELY. HIS ARM WAS SAVED BY

PROMPT TREATMENT. MEANWHILE MADAN BROUGHT DOWN THE RUDDERLESS PLANE SAFELY – NO SMALL FEAT IN ITSELF.



LOST IN A STORM, A TRANSPORT PILOT WITH 3 PASSENGERS SENT A CALL FOR HELP. ON THE GROUND A QUICK THINKING RADIO OPERATOR HAD OVER 100 AUTOS ARRANGED IN A CIRCLE. THE BIG PLANE LANDED SAFELY IN THE ILLUMINATION OF THEIR HEADLIGHTS.

WHILE R. FIELD, THE PILOT, HUNG HEAD FIRST FROM A WING TO LASSO AND FASTEN A LOOSE LANDING WHEEL, DON LONG, WHO HAD NEVER FLOWN BEFORE, HAD TO HANDLE THE CONTROLS TO SAVE THE LIVES OF THE PILOT, HIMSELF AND TWO OTHER PASSENGERS.



BOOMERANG

The things that happened then took place so fast that Hank couldn't follow them. Martinez whirled; his right hand dived——

Nerves? What are they?

by Harold Montanye

"LONG HANK" BREWER fastened the chin strap on his helmet as he "shimmied" his shoulders under his parachute harness to make the straps sit easier. His lean, lined face was haggard and he noticed that his fingers were trembling.

"Don't let your mind wander, Brewer," the swarthy, dark-eyed man said who stood beside him. "You come through or else. You understand that?"

Long Hank turned the two bits of blue steel that were eyes on the man and nodded his head. The man sidled away two steps, as Brewer's eyes bored into him. They were like two gimlets boring into his brain, and in them was an expression that terrified him.

"I won't forget, Olmer," Brewer said. "You've got me." He said it with the dull cadence of a man reading his own death sentence. Then his voice rose just a trifle and he smiled. "But don't forget, Olmer, I'm going to get you. You have me now. You have me where the hair is short; but after I've paid my debt I'm going to find you if I have to follow you all over the world."

"You'll change your mind about all that," Olmer said, nervously. "You'll thank me after the whole thing is over. You have all your instructions right?"

"I have them right," Long Hank said. "Now get out of here before I kill you."

Olmer's lip curled as he started to say something, changed his mind, and left abruptly. Brewer's icelike eyes followed him until he was out of the room. Then he stifled something that was very much like a sob and made ready to follow him. His legs felt like great iron weights as he dragged them across the room. Something inside him seemed to be squeezing his heart. He clenched his big fists and rubbed one of them across his eyes as though to rub out a horrible vision. He felt alone, deserted.

And from now on, he knew, that feeling would follow him throughout the rest of his life. He was selling his birthright for——

"Hi-yah, toots!" boomed at him as he stepped outside the hangar. He took his fist away from his eyes and tried to grin at the merry face of Major Stephen Knox, U. S. A. But his mental anguish must have been written on his face. Knox's face became serious and his eyes narrowed as he studied Brewer.

"What's the matter, fella?" he asked, anxiously. "Nerves?"

"What are they?" Long Hank asked and he managed a smile. "I don't think I've ever eaten any. What do they taste like?"

Knox's breath exhaled from his lungs in a loud *"Whew!"* and his round, red face was wreathed in smiles again.

"You had me worried for a minute," he said. "When a test pilot gets the jitters he better not even try to climb apple trees." He swung around and pointed at the little knot of men clustered around a sturdy, high-winged cantilever monoplane that was being warmed up on the apron. Long Hank's steel-blue eyes opened in admiration as he read the speed and power and deadly punishing power in the little single-seater fighter he was going to test.

"I want to tell you something, Hank," Knox said. "If we're satisfied after your test, she'll go to Dayton for further inspection. If she comes up to expectations, she's going to be dismantled and kept an absolute secret. Machines will be built so we'll be ready to turn 'em out in mass production in case of war. She's the tops for fighting craft if she'll do what Meredith says she'll do."

"What'll she do?" Long Hank asked, and that frightened look came back into his eyes.

"I think you'll be able to get her up to four hundred," Knox said in a voice that was almost a whisper. "You can hang her on her prop and she'll climb almost vertically, and she'll turn at right angles. You want to watch her. She's tricky. She'll black you out if you aren't careful, she's so quick on the stick. She's the greatest fighter ever put together." Knox's voice dropped even lower. "There have been three attempts to steal her plans and specifications. We chose you to test her because we know you can keep your mouth shut. We have confidence in you, Hank."

Long Hank's eyes sought the ground for a moment. He kicked a pebble to the right and another one to the left and nodded his head. "I see," he said.

"You understand the situation?" Knox asked.

"Yeah," Hank said, "I understand. It's all pretty hush-hush."

"That's the idea," Knox said.

His voice droned on in Hank's ear, but Hank was not listening to what he said. He was thinking about other things, things that took him away back in his life. He was thinking what a mess he had made of it. And this was the end. He would have to disappear into oblivion when this thing was over. He would have to take another name and go skulking through life like a hunted animal.

Again Knox's voice penetrated his consciousness. "You sure you're all right, Hank?" it asked for the third time.

"I'm O. K., Steve," Hank said and he managed a twisted grin. "Let's go!"

"Meredith wants to give you some final instructions," Knox said. "He doesn't want you to get out of sight of the airport. There is good visibility to-day, so it shouldn't be hard for you to stay in sight, in spite of your speed."

"He wants just the regular routine stuff?" Hank asked.

"That's it," Knox replied, "and a couple of power dives."

Steve listened while M. L. Meredith, head of the aviation company who had designed the little, single-seat fighter, gave him instructions and a few words of warning. He nodded his head and listened while his eyes roamed over the lines of the silver bullet beside him.

"She'll cruise at close to three hundred and thirty miles an hour, using only seven hundred of her eleven hundred horse power," Meredith said. "I think she'll do four hundred opened up. You can turn oxygen directly into the cabin above twenty thousand feet. But you won't need that to-day. Stay within our sight at all times. Good luck to you, Brewer."

Long Hank grinned that twisted grin again and took Meredith's outstretched hand. When he touched it he could feel his arm burning all the way to his shoulder. He wrenched his eyes away from Meredith's and opened the cockpit door. He studied the retractable periscope above the single bucket seat, the Sperry gyro-magnetic compass and gyro-pilot, artificial horizon and directional gyro, and listened to the sweet song of the idled motor.

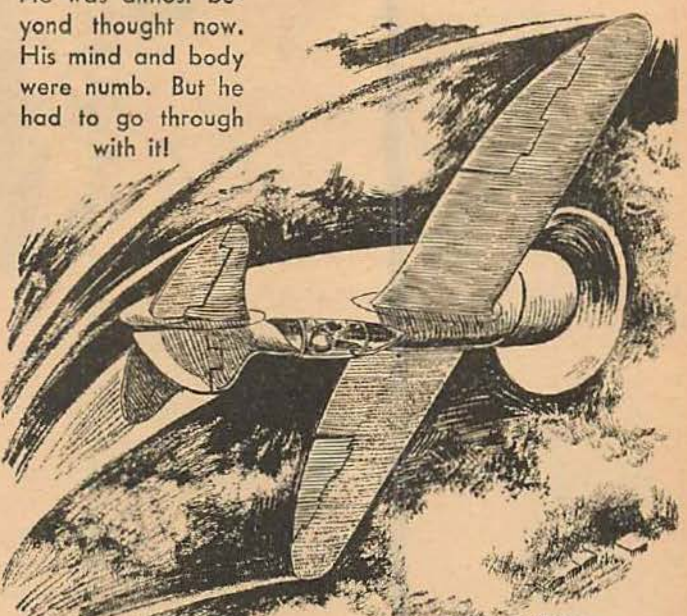
"Everything but a shower bath and a toe-nail clipper," Steve Knox chuckled at his side.

"She's a honey," Hank said as he slipped down in the bucket seat, pushed open the throttle and listened to the roar of the powerful eleven-hundred-horse-power engine.

He sealed the cockpit door and flipped a hand above his head in farewell. Twenty hands returned his greeting. There was a roar and the tiny fighting ship raced across the field and left the ground with terrific speed. It soared upward with the speed of light and became a mere pin point to the north, made a long sweeping turn and raced back above the airport at terrific speed.

The little knot of men on the ground watched it with unbelieving eyes. They gazed at one another and shook their heads in disbelief.

"You've done it, M. L.," Major Knox said to Meredith.



He was almost beyond thought now. His mind and body were numb. But he had to go through with it!

"You haven't seen anything yet," Meredith answered.

Eight thousand feet above them Long Hank Brewer was fighting for his soul. His lined, haggard face was a horrible thing to behold, as he automatically nursed the little fighter like a mother with her firstborn.

He could see Olmer's leering face and the threat in his eyes. "You come through or else," Olmer was saying to him.

Hank jammed the stick of the little fighter forward until it was diving vertically toward the earth, then eased it back and forward again until it leveled out in an inverted position. He rolled it to an upright position with a speed that drew a black line across his eyes, and zoomed upward.

He clenched his teeth and cursed as he remembered the beginning of the whole thing with Olmer. It had all seemed innocent enough. Olmer had appeared from nowhere with a twenty-five-thousand-dollar cabin job that Hank *liked* to fly. He seemed to have plenty of money and had introduced Hank to people who seemed to have as much. There had been a series of parties. Olmer had loaned Hank money, urged it on him. Hank had been foolish enough to take it.

Everything became more and more tangled in the giddy whirl in which Hank found himself. There were parties and women and one thing after another. Hank thought he was having the time of his life. He was young enough so that his nerves were not affected. At least they were not affected until the day Olmer came to him with threats about some papers he, Hank, had signed while he was drunk. He couldn't deny that it was his signature and that he had signed Olmer's name also. If he did deny it he couldn't prove it.

He had expected that Olmer would laugh the thing off as he had laughed a lot of other things off. Then, it finally came to him that Olmer wanted something. He wanted something for the price of ignoring that forgery. It wasn't long before Hank realized what it was he wanted. He wanted Hank's soul.

Hank saw the whole slimy game from beginning to end now. He knew that Olmer was working for some foreign power. He was a spy. He had known about the Meredith plane and he had known that Long Hank would be the man chosen to test it. How he knew those things Hank didn't know. But it was only too evident now.

"Don't let your mind wander, Brewer. You come through— or else——"

Hank had been both horrified and indignant when Olmer worked around to the thing he wanted. He edged up to it slowly, to give Hank a chance to get used to the idea.

Then, he had told Hank that he wanted the Meredith single-seat fighter intact. He worked on Hank for days, until the whole plan was unfolded. Hank would take the ship up for its tests. After a few minutes—these few minutes that are passing now, Hank thought—he was to stick the nose of the plane south and make a landing at a certain point in Mexico. He even had the course he was to follow in his pocket. When he arrived there he would be met by men who would take the plane off his hands, give him twenty-five thousand dollars, his I. O. U.'s and the papers he had forged.

Hank wished he had Olmer's soft, white neck between his two hands.

A vision of Ann Nichols' soft blue eyes and copper-brown hair floated before his eyes for one tantalizing moment. Olmer had roped her into the thing, too, and had pointed out to Hank that her name would be dragged in the dust if the whole ugly thing came to the surface. He had met Ann Nichols only a short time before, but he knew the moment he saw her that he loved her. They both knew it and they acknowledged it. This would mean that he would never see Ann Nichols again. But she would come out of the thing clean.

She was the deciding factor in Hank's mind. He knew that he could take any punishment Olmer wanted to hand out. But he couldn't see Ann suffer for his stupidity.

"She'll forget," he said, softly, to himself. "No one will ever know for sure what happened to me."

He brought the little silver fighter up and over in a loop which he followed with an inverted loop to make a Figure 8. He smiled grimly to himself as he completed the difficult maneuver. Meredith ought to get a kick out of that feat. Only a ship with tremendous power could be brought through such a move.

He then hung the little craft on the propeller and took it upstairs at a rate of seven thousand feet to a minute. That, he thought, is performance. It was the greatest fighter he had ever kicked into the air. It was everything Meredith had claimed and more.

And he, Hank Brewer, was going to sell it down the river to the enemy. By doing it he would become as slimy as any common sneak thief. Worse, if anything, because he was betraying his country.

He bellowed a curse that rang in his ears above the roar of the powerful motor in the nose. His head came forward on his hand for one awful moment. Suppose he stuck the nose down and plunged into the Pacific? That would be a way out. But it would leave Olmer free to go on with his nefarious trade.

A tiny light burned for an instant on his radio panel. He flipped the key and spoke into the microphone.

"Orders to dive her twice and then bring her in, Brewer," a voice said in his ear.

"O. K.," Hank answered and flipped the key. He saw that he had ten thousand feet on his altimeter when he stuck the nose down. That was low for a power dive. A gale raced with him as his air-speed indicator climbed to five hundred and fifty miles an hour, six hundred. He eased the stick back at five thousand and waited for the wings to tear off. But they didn't tear off. The little ship pulled out without a protest. It was then that Hank knew he had to make up his mind. He made it up as he eased out of a shallow dive.

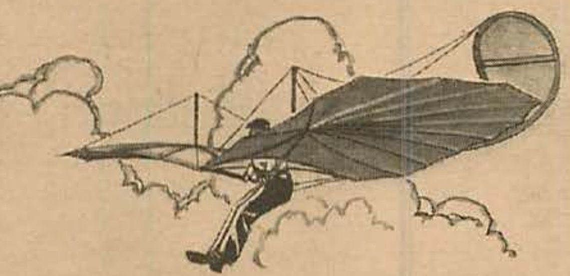
He flicked a hand to the little knot of men below him as he stuck the nose upward again and began a long, sweeping turn. He gathered speed as he headed north with the throttle open. The air-speed indicator climbed to three hundred and eighty miles an hour. The world below him faded away as he opened the oxygen jet and climbed to twenty thousand feet. He brought the little ship around in another fast curve and stuck the nose south.

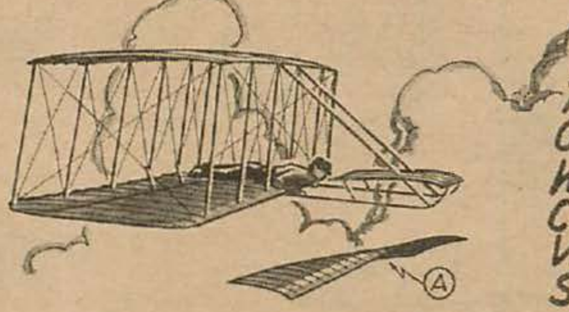
He pulled a small piece of paper from his overall pocket, studied it, and stuck the nose on a true course to a point in Mexico. The mists of the

(Turn to page 84)

Control Development

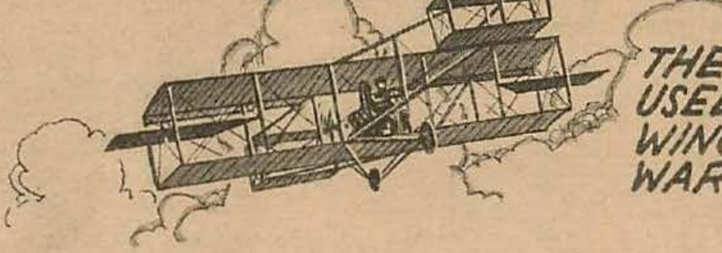
THE LILIENTHAL GLIDERS OF 1896 WHOSE "CONTROL SYSTEM" CONSISTED OF THE SHIFTING OF THE WEIGHT OF THE PILOT. THE MACHINE WAS VERY UNSTABLE, FORCING THE PILOT TO SHIFT HIS WEIGHT CONSTANTLY





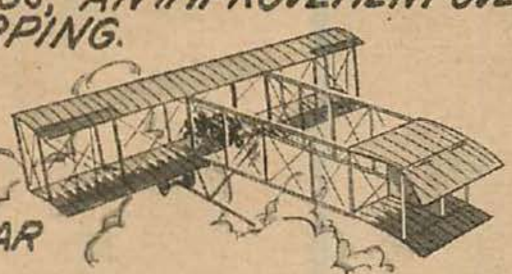
IN GLIDING FLIGHTS OF 1901 THE WRIGHTS USED A TWISTING OR WARPING ACTION OF THE WINGS FOR LATERAL CONTROL COMBINED WITH A FRONT "ELEVATOR" TO PREVENT DIVES. "A" SHOWS WARPING EFFECT.

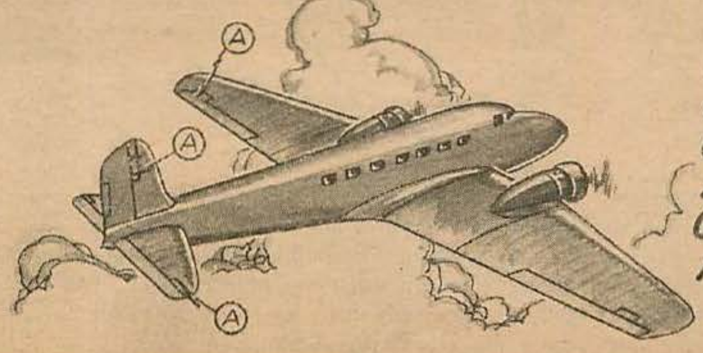
WING-WARPING WAS STILL USED IN 1908 WITH THE RUDDER AFT AND THE ELEVATOR FORWARD AS IN THIS HENRI FARMAN BIPLANE



THE 1910 TYPE CURTISS PLANE USED AILERONS BETWEEN THE WINGS, -AN IMPROVEMENT OVER WARPING.

EARLY 1910 ALSO SAW THE FIRST PLANES WITH WING AILERONS AND RUDDER AND ELEVATORS IN THE REAR





THE MODERN SHIP WITH ITS BUILT-IN BALANCED CONTROL SURFACES. SMALL BALANCING AREA, AHEAD OF HINGE, "A" ASSISTS IN THE MOVING OF CONTROL AREA AGAINST WIND PRESSURE

MODERN MOTORS

Article Four—
The DIESEL Engine
Its place in Aviation

by
Arch Whitehouse
and
Alexander N. Troshkin
Guggenheim School of Aeronautics, New York University

IS the Diesel engine the hope of aviation's future?

Will the use of the Diesel engine cut down fire hazard? Can we expect greater efficiency from the compression-ignition engine within a short time? Will all our great airliners, our monster bombers, our giant seaplanes, be powered with Diesel engines within ten years?

Is the Diesel cheaper to operate? Is it easier to service, and what is America's position in the race for a Diesel that will fit the aviation problem?

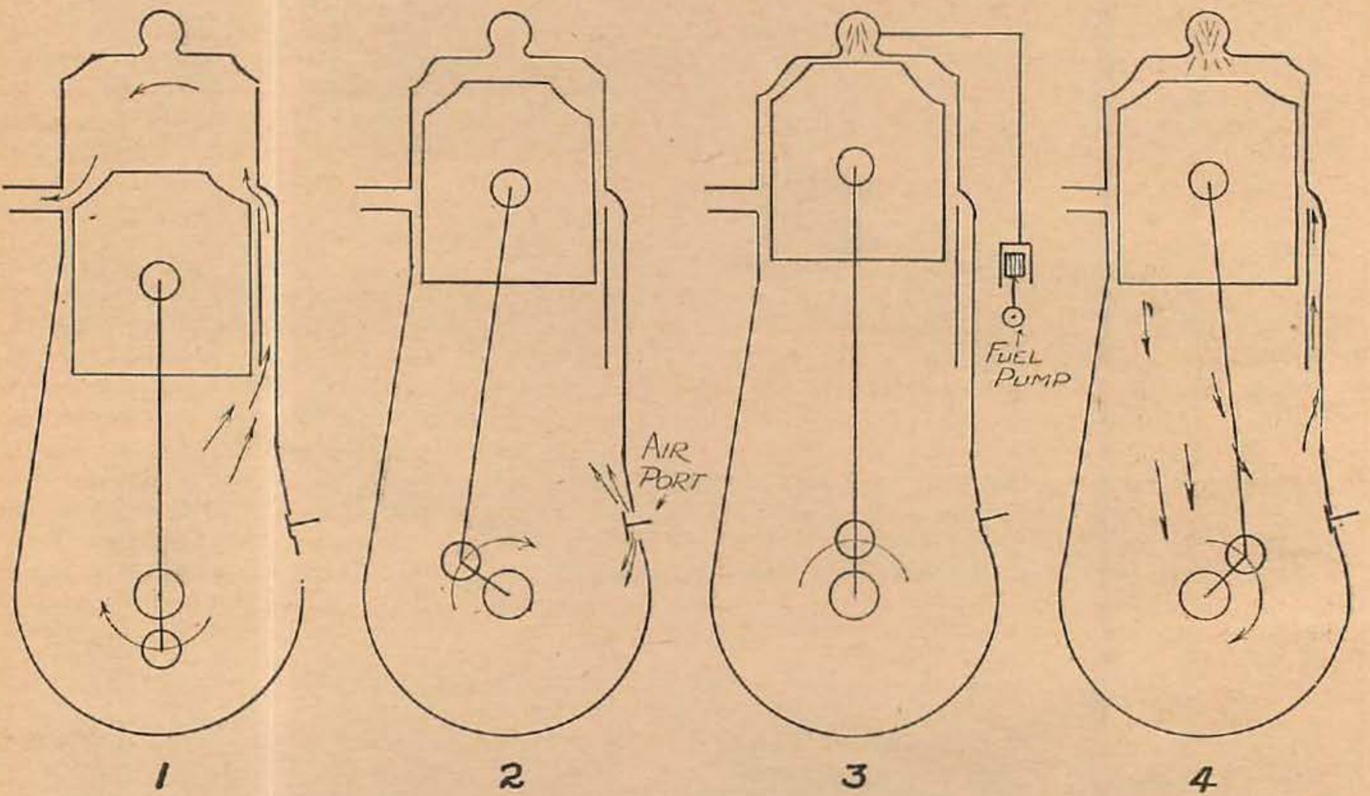
But we are getting ahead of the lesson. What *is* a Diesel engine?

The first Diesel engine was built in 1892 by a man named Dr. Rudolph Diesel, and his first model operated on pulverized coal. A later model was introduced in which powdered coal was injected into the cylinders by air and fired, or burned, by the heat generated by the compressed air in the cylinders. The engine was a success, but not commercially profitable.

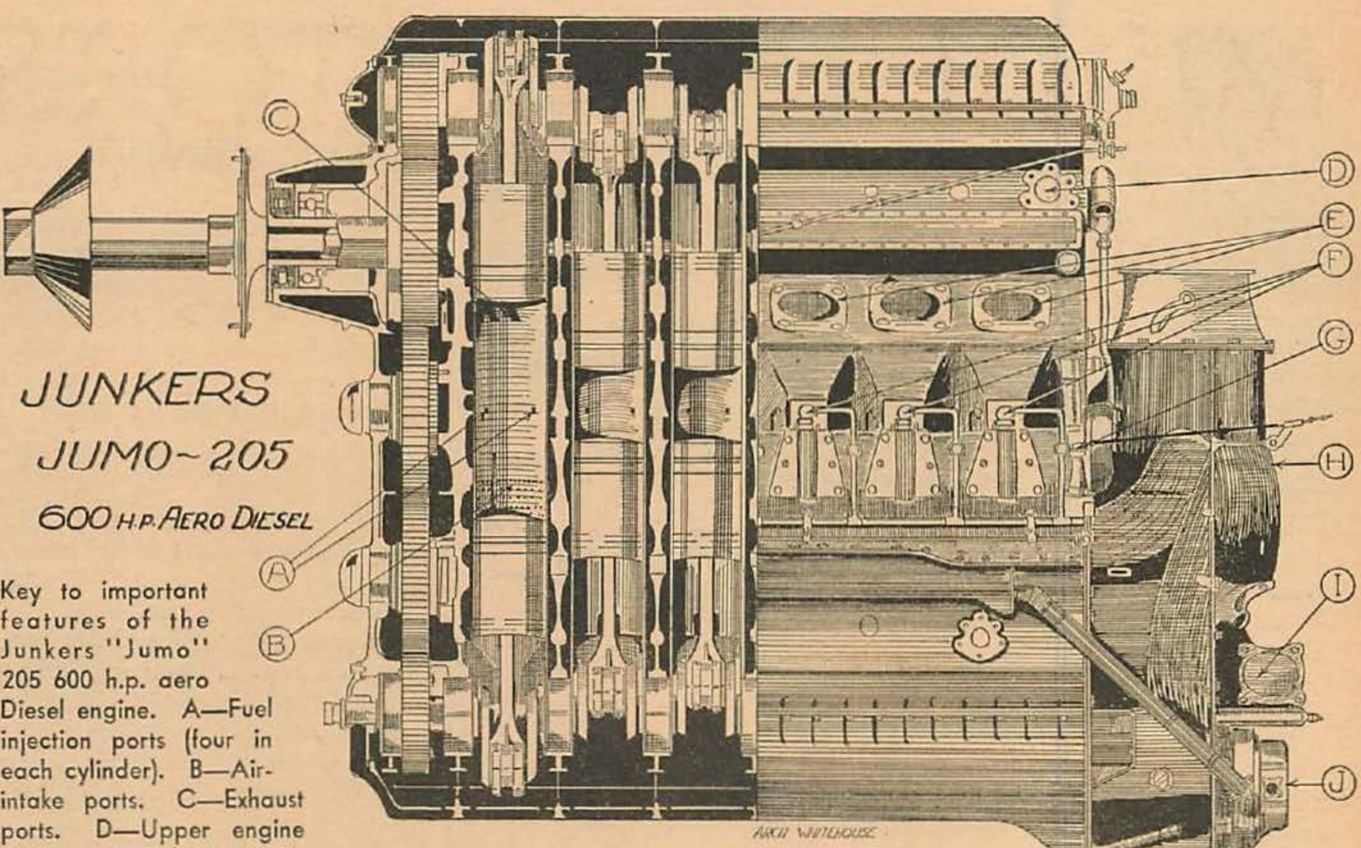
It must be recalled that at this period the steam engine was making rapid strides all over the world and its use in commerce and manufacturing made it the most important means of power of the time. Hornblower had given the world the compound engine in which the steam exhausted from one cylinder was still further expanded in another. The steam turbine, in which the power was converted into a rotary motion instead of a reciprocating motion of the piston, came along at this time.

What chance did the mysterious Diesel engine have against all this competition?

But men have dreams and here and there we find a man who has the courage of his convictions. Adolphus



Explanation of the "Clerk" or two-stroke Diesel system. In Fig. 1 we see the action of the inlet or scavenging stroke. Fig. 2 shows the start of the compression stroke with the air valve in the crankcase open. Fig. 3 shows the piston at the top of the compression stroke and the spray of atomized oil fuel being injected. Fig. 4 shows how the spray is fired by the heat of the compressed air which starts the power stroke. All ports are closed and new air from the crankcase which is slightly compressed, starts up the air port for the second cycle while the piston starts down and begins the crankcase compression again.



Key to important features of the Junkers "Jumo" 205 600 h.p. aero Diesel engine. A—Fuel injection ports (four in each cylinder). B—Air-intake ports. C—Exhaust ports. D—Upper engine bearer. E—Exhaust manifold connections. F—Fuel injection nozzles. G—Fuel flow regulator. H—Rotary air blower. I—Main air intake. J—Water pump.

Busch of St. Louis believed in the engine and brought out a Diesel in 1898. Our history does not explain what success he had, but he at least planted a seed, or created a new interest in this form of motor.

The great law of the Diesel is heat. Without heat generated in a cylinder there could be no Diesel. But this is an old law. Any machine that converts heat into mechanical energy comes under the classification of a heat engine. This includes all reciprocating engines of steam, turbines, and internal-combustion engines. Gas and gasoline engines, oil engines and Diesel engines all come under the head of internal-combustion engines.

The law is so old, they tell us that long before the Christian Era there were forms of steam engines, but they were considered playthings. A few early priests have been credited with using steam to open doors or to raise large bodies. Who knows but what the Egyptians used steam to build the Pyramids?

We have seen the general make-up and power sequences of the gasoline engine in earlier articles and we know the cycles of operation. We know that gasoline vapor compressed in a cylinder is ignited by an electric spark and converted into power through a piston, connecting rod and a crank shaft.

What then, is the difference between the gasoline motor and the Diesel?

Actually, there is very little difference. In general, the power is created by the burning of a vapor which expands and forces a piston down a cylinder. But the method of getting the vapor to the cylinder and firing it is decidedly different.

As we stated before, the first Diesel engine used pulverized coal as a fuel. This was admitted in small quantities to the cylinder through a rotary valve, and, at the highest point of compression, the heat generated by high compression, fired the pulverized coal and developed the power stroke.

This is a point you must first get into your mind when attempting to solve the mystery of the Diesel. Air compressed in a cylinder assumes certain thermal characteristics and becomes heated. Next time you pump your bicycle tire with a foot pump, notice how the lower part of the pump cylinder becomes warmer and warmer as you increase your efforts. This is not as the result of friction, for you will notice that the upper part of the cylinder remains cool.

This high-temperature air takes the place of the spark plug. It fires a mixture of crude oil which has been injected into the cylinder through a special nozzle fitted into the cylinder head. The burning of this atomized oil, which is, of course, mixed with the compressed air, sets up pressure—just as the gasoline vapor does in the gasoline engine—and provides the power stroke.

That, in general, is the theory of the Diesel engine. We see, also, that there appears to be two outstanding facts concerning it and its use in aviation: First, we have no ignition problem, for there are no spark plugs, no magnetos and no necessity for shielding against radio interference; next, we realize that if the Diesel uses crude oil the fuel costs must be lower and much safer to handle. There should be no danger of fire after crashes, for no volatile fuel is carried to spatter overheated portions of the motor, or to catch the sparks of ignition systems.

These are important points in their way, but the critics of the Diesel do not put too much faith in these so-called advantages.

The cycle of motion employed in Diesel engines—at least those designed for aeronautical purposes—is known as the two-stroke or the Clerk system, which all who tinkered with early types of motor-cycle

(Turn to page 82)

"Dear Harry-"

Letters of an Air Student to His Friend

by George Swift

From—STEVE STERLING,
Skyways Air School,
Greenvale, Calif.

To—HARRY REED,
Burton, Pa.

DEAR HARRY,

Yesterday was a day I will long remember. In the morning Kelvin and I went seaplaning with highly exciting results. In the afternoon Kelvin made the last flight of his flying career. And what a flight it was.

But continue on and learn the breathless details.

"How about a seaplane ride?" Kelvin inquires about eight a. m. of the fateful day.

"O. K." I answer incautiously, and the deed is done.

Five minutes later we are speeding over the road and I am being made acquainted with the story behind the coming adventure. At the time I wonder why little cold streaks seem to be meandering up and down my spine, but not once do I suspect that they are warnings of what is to come.

It seems that Kelvin has become acquainted with a pilot who flies a seaplane at a near-by lake, and after some fast talking has persuaded said pilot to lend the seaplane for a fishing trip.

"Y'see," Kelvin explains, "we can kill two birds with one stone by getting in some fishing and some seaplane flying at the same time."

Which sounds very nice. Only, somehow, the expression "kill two birds" does not set so well with me. But maybe I am just imagining things. Perhaps I ate too much at breakfast. Anyway, we are aviators, not birds.

The lake turns out to be a pretty large one. The seaplane turns out to be a powerful-looking job, almost new. And its owner, Martin by name, turns out to be not exactly leaping with joy to see his plane flown by two not-so-experienced fliers. In fact he tries to back out of the agreement, but Kelvin talks him into line again.

With the motor wound up and fishing rods and tackle stowed away, we toss a coin to see who will pilot the water-hopper first. I win.

Opening the throttle, I head out into the lake. After a run I carefully tip up the elevators. We rise, slowly, and leave the water.

Well out in the lake, Kelvin takes over the controls. He banks, dives, climbs, and generally tests out the ship.

"Guess I'll try a landing," he yells over his shoulder.

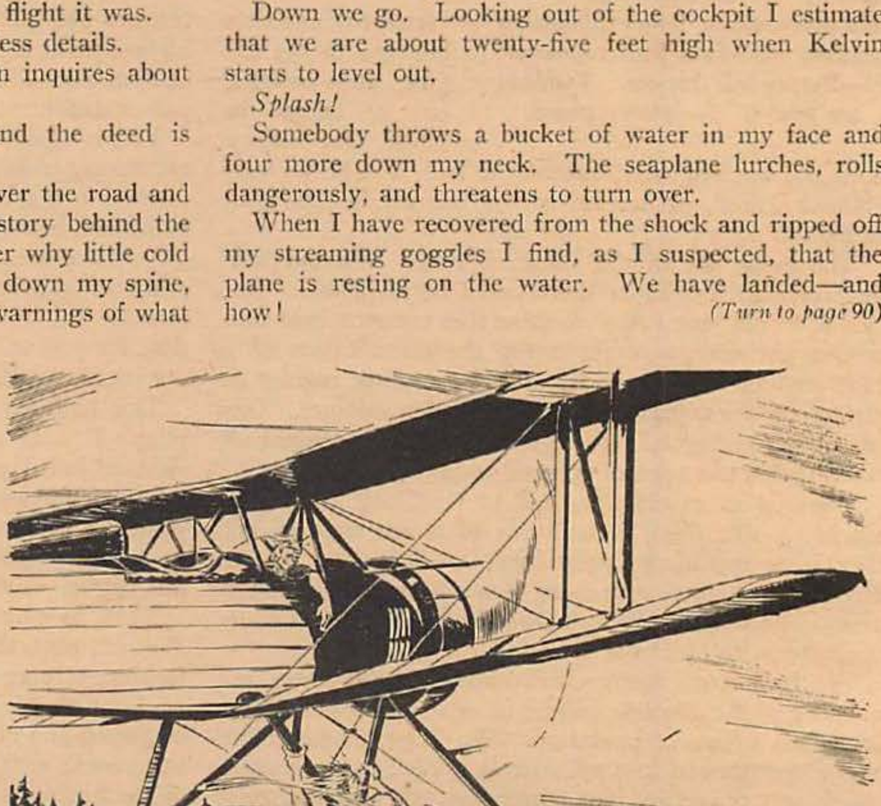
Down we go. Looking out of the cockpit I estimate that we are about twenty-five feet high when Kelvin starts to level out.

Splash!

Somebody throws a bucket of water in my face and four more down my neck. The seaplane lurches, rolls dangerously, and threatens to turn over.

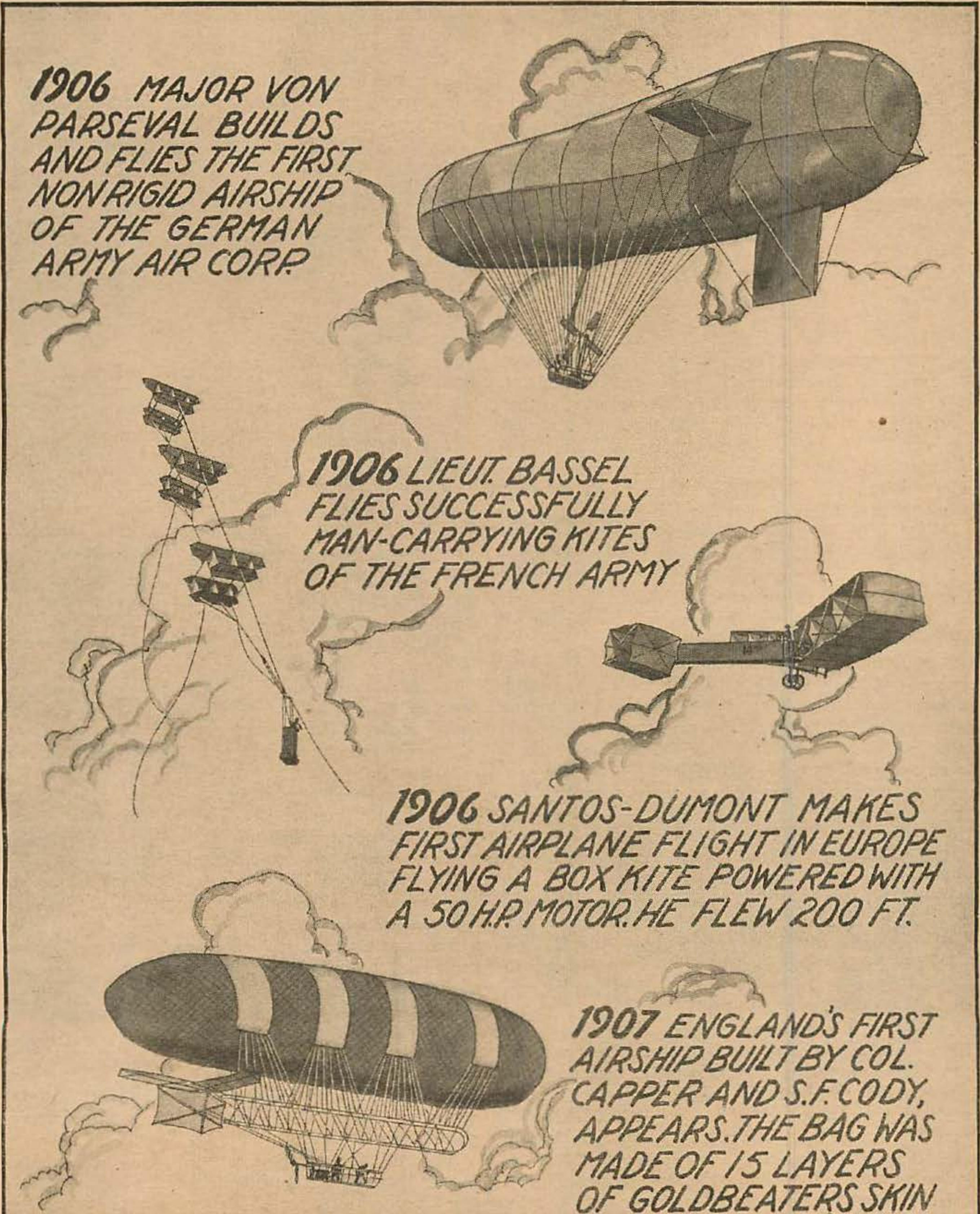
When I have recovered from the shock and ripped off my streaming goggles I find, as I suspected, that the plane is resting on the water. We have landed—and how!

(Turn to page 90)



My hand touches a pontoon, slides off the smooth surface. Now or never! I fling out both hands at a strut—grasp it——

Pictorial History of Man in the Air



1906 MAJOR VON PARSEVAL BUILDS AND FLIES THE FIRST NONRIGID AIRSHIP OF THE GERMAN ARMY AIR CORP.

1906 LIEUT. BASSEL FLIES SUCCESSFULLY MAN-CARRYING KITES OF THE FRENCH ARMY

1906 SANTOS-DUMONT MAKES FIRST AIRPLANE FLIGHT IN EUROPE FLYING A BOX KITE POWERED WITH A 50 H.P. MOTOR. HE FLEW 200 FT.

1907 ENGLAND'S FIRST AIRSHIP BUILT BY COL. CAPPER AND S.F. CODY, APPEARS. THE BAG WAS MADE OF 15 LAYERS OF GOLDBEATERS SKIN

CRASH COURAGE

He'd busted planes before—but not like this—the Spad screamed—nose down——

by ORLANDO RIGONI

CALVIN HARDE kicked the old Spad around. The newly painted cocardes gleamed in the California sunshine. Harde crouched over the stick like a panther. His eyes were rivets, staring down the two thousand feet to the French village that had sprouted miraculously from the soil of San Fernando Valley.

Harde knew that this would be a tricky crash. He'd busted planes before, lots of them, but not just like this. He glared across the sky for the two Fokkers. They came with guns jumping and engines roaring full out!

Harde rolled out of a half loop, and whipped back upon them. Across the sky was another Spad. Louie Sykes, Harde's pal, was in that other Spad. Sykes roared over to chase the Fokkers away. Harde began his death spin that should crash him in the village.

He made a terrifying loop that broke at the apex and let the Spad slip off on a wing. It turned over then, without control. Harde hunched down and let the stick thrash. The earth became a big saucer that was whirling madly. He laughed—a grim, hard laugh. He'd show them how to crash a ship right!

The Spad screamed, nose down. Wires singing, wings drumming, fabric fluttering! Down—down—down! One thousand feet with his eyes going black in his head. Two thousand feet! He had to flatten now—he had to ease in on his belly——

At that instant, Harde saw something that made his heart pound. Louie Sykes, in the other Spad, was screaming down out of control, right across Harde's prop. Harde screamed a wild curse. He was going to crash into Sykes. He was going to kill his buddy, unless—unless——

In that split second, a thousand thoughts crossed Harde's mind. Right under him, blocked out now by Sykes' plane, was the flimsy French cottage that was built especially to break the force of his crash. Beyond that cottage was a street, but it was a street filled with struggling doughboys. Harde knew that he could jump that cottage and miss Sykes, and land out in the street. To do that meant crashing into the struggling men in the street. It meant killing or maiming a score of those men. It was twenty lives against one, and Harde knew what he had to do.

With a sob jerking from his lean throat, and tears welling to his deep eyes, Harde held the stick rigid. Right before him lashed the wings of the other Spad. He could see Sykes' terrified face staring at the ground. White, that face was, like new chalk. Harde saw Sykes look at him just as they hit.

Harde felt the flimsy craft under him buck and surge. He felt the landing carriage fold back—felt the wings whip off and the engine buckle back on the cradle. Then there was a mighty roar—a burst of flame!

Harde tore himself from his pit. The director of the picture was running over. The emergency fire truck was clanging up with hoses spouting. Harde leaped at Sykes' ship.

"Sykes! Sykes!" he cried hopefully, but there was no answer. Harde saw a pile of rags in the broken cockpit, and dragged it out. A doctor shoved Harde out of the way, and Harde cursed him. Then the reaction set in. Harde trembled from head to foot. Sobs racked his body. Somebody put a hand to his shoulder and told him not to take it so hard.

"Hard?" he cried hotly. "Sykes was my buddy. I've killed him—killed him! For what? So a bunch of dumb picture fans might get a thrill. Well, I'm through! Done! Washed up!"

The director came over, took hold of Harde's arm. "You can't quit us now, Harde. We've got to make some retakes. You're not the quitting kind."

Harde could feel the fire of hate sweep through him. "Damn you all!" he cried. "I tell you I'm done. You can laugh at me—pity me—but I'm through! I'll never handle another plane as long as I live!"

Trembling wildly, Harde watched the ambulance roar off the field. Some of his heart and soul went with it. For a few dollars, and a morbid thrill, he had killed his pal. He legged grimly off the field, his ears deaf to the entreaties of the director and his staff who followed him.

"I'll have you blackballed," the director threatened. "I'll have you ruled out of pictures——"

"Blackball and be damned!" Harde cried. "I tell you I'm through. I'll never handle another plane. Man wasn't made to fly in the first place!"

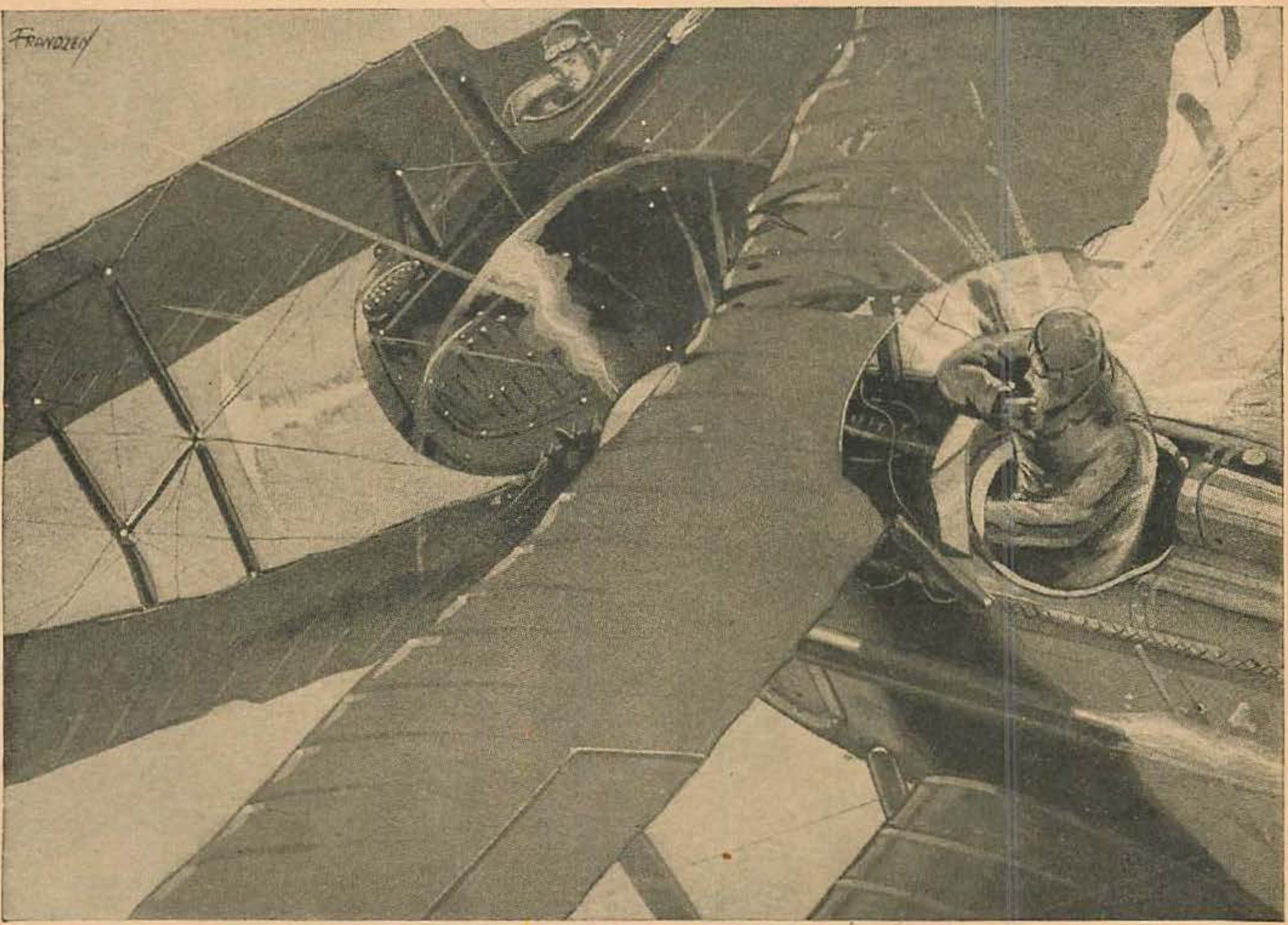
Sykes was unconscious all of that night. Harde tried to drown his jitters in joy juice, but everywhere he went people who knew him in the picture game stared at him with pity or contempt. Harde didn't know which. His mind became stubborn and hard. The news of his washout seemed to precede him like a foul odor.

Harde finally succeeded in getting drunk enough to forget himself. He felt like an outcast, and went home to dream wild dreams.

The next morning he showed up on the set. Harde gritted his teeth at the director's knowing smile. He avoided the hand slaps and condolences of his friends. He'd show them that he wasn't yellow. He'd show them that he could take it.

He legged through the confusion of that war scene and out to the patched and dirty Spad that awaited him. He buttoned up his flying togs and jerked his helmet down. He fought back the misgivings in his heart and stalked over to his ship.

But a strange, overpowering fear gripped him as he put his hand to the pit of that ship. He began to shake like a man with the ague. He cursed himself for a fool and coward. He couldn't stop the quivering of his flesh and the trembling of his bones.



In that split second, a thousand thoughts crossed Harde's mind. Then there was a mighty roar—a burst of flame!

A strange nausea overcame him. He grew weak and sick. He gripped his hands until his nails bit into the flesh. He felt naked and ashamed before the curious eyes of the men who gathered about him. He staggered off the set and over to his car.

Harde was through—washed up—done. One of Hollywood's greatest stunt men was through. Harde knew the saying that once you lost your nerve you couldn't come back. To hell with them all, he didn't want to come back!

He staggered into his car, roared off the field. He didn't know where he was going. He didn't care. Sykes was still unconscious, so he didn't try to see him. He just drove on away from Hollywood.

Eighteen hours later he pulled up in Salt Lake City. He still had on his flying togs, and people stared at him as he legged across the hotel lobby and ordered a room. He slept until the afternoon of the next day.

When he got up it was soggy outside; clouds hung low across the Wasatch Mountains. Out on the salt flats toward the lake, the fog clung close to the ground. Harde pulled on his clothes, and feeling out of place, he got in his car, and drove out to the airport.

He was glad nobody knew him, there. He wondered how Sykes was making out and bought a paper. He learned from the paper that Sykes was in a bad way. He needed a brain operation that not a doctor west of Chicago was qualified to make.

"Why don't they get that doc?" he asked himself fiercely. "Why don't they do something?"

He climbed a stool at the lunch counter and ordered something to eat. He noticed the efficient, calm-eyed brunette behind the counter, eying him curiously. As he gulped his food, he was startled by her soft voice breaking into his consciousness.

"You're Calvin Harde, aren't you?" the girl asked slowly.

Harde stiffened. "If you say so, I guess I am."

"I've seen your pictures. I'm an aviation fan, Mr. Harde, and I've seen you make some thrilling crashes on the screen. I—I hope it isn't true, what the papers say," she said, avoiding his eyes.

"What do the papers say, sister?" Harde asked, definitely eager to talk to some one.

"They say that you lost your nerve. They say that you're through—washed up. They say when a man loses his nerve in the stunt game he can't come back."

Harde swallowed the lump in his throat. He was thinking of that awful moment when he had attempted to go on with the picture. He was thinking of the way he had grown weak and sick at the thought of flying.

"Maybe they're right," he said in a dead, flat voice.

He noted the edge on the girl's words as she said, "So you're running away. You're a fool, Mr. Harde. That's something you can't run away from. You're running away from yourself, or trying to."

"That's my business," he snapped bitterly. He knew she was right, and it increased his melancholy.

"There's only one way out, my friend," the girl said sagely, "and that is to turn and fight the thing that frightens you."

"I'm done with flying," he said definitely, staring out the window at the wet, fog-shrouded field. "God didn't give man wings; he's not supposed to fly. I'm staying on the ground, and that's final. Give me some more coffee!"

At the same instant, Harde heard excited voices out at the dispatcher's desk. "They're sending that unconscious stunt flier through," the dispatcher said crisply. "Rogers has just called in from No. 16. He's over the emergency field the other side of Poulter Summit, flying blind. He'll be here within fifteen minutes."

"Or in the lake," the field man added grimly. "He can't make a landing here in this fog. Better send him on to Rock Springs."

The dispatcher shook his head. "Can't do that. He's low on fuel and conditions at Rock Springs are no better than here. We'll have to chance bringing him down here."

"It's suicide," the ground man insisted. "That wounded man can't stand a crash-in. They've got to get him to Chicago within ten hours if that operation is to be a success."

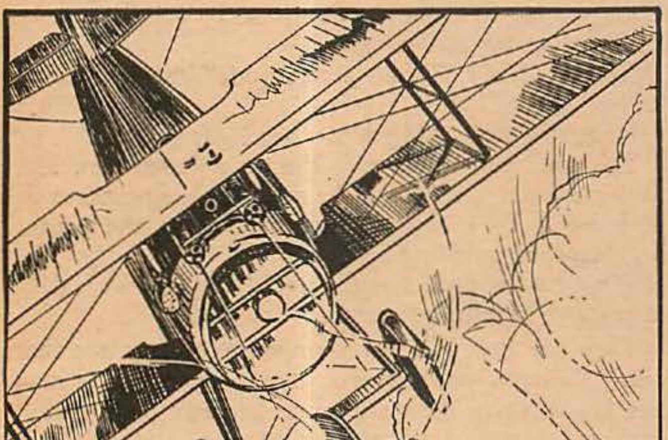
Harde slid off his stool, stood for a moment, dazed. He wanted to run away. He wanted to hide from this hateful thing that was following him. Sykes was coming down here with ceiling less than fifty feet. It couldn't be done!

Harde ran wildly into the dispatcher's room. "They can't come down in this fog!"

"Who are you?" the dispatcher demanded hotly.

"Never mind that," Harde snapped. "I tell you they can't bring him down here."

As if in answer, the drone of mighty engines roared and swelled and hammered down through the curtain of fog. The radio hacked into life.



Harde knew he was going too low. He was taking a desperate chance. He was going to crash—but he didn't care.

"Hello, Salt Lake. Hello, Salt Lake. Rogers speaking from No. 16. Can you hear my engines? Visibility up here zero. Gas low on account of fighting head wind all the way from Vegas. Can you get us down?"

"Hello, Rogers. Hello, Rogers. Ceiling zero on port. Can hear your engines. Believe you are too far east. Circle west by north."

Harde listened to this conversation like a man in a daze. He knew the hopelessness of the situation. The big ship could never hit the drome for a landing. On the one side of the field were the high-tension lines. On the other side were the hangars.

Rogers' voice crackled from the loud-speaker. "Have gas for ten minutes, can you guide us in?"

Harde saw the white despair in the dispatcher's face. There was death staring from the man's eyes. Harde knew that they couldn't guide them in by the engine sound. The fog dissipated the roar of the engines and made it confusing. There was only one way to get them down.

Harde stood like a man of stone. Just one way to get them down. He saw the ground man run out the door. Harde knew that Sykes was up there, ready to make his final crash. Harde staggered out upon the field.

Mechanics, ground men, and spectators were staring up hopelessly at the gray sky. There were breaks in the fog a hundred feet high, but beyond that nothing could be seen. The hum of the engines, roaring out their swan song, swelled and eddied and crashed about in the fog.

Harde stood out there with his face staring up into that gray mass of vapor. His lips were moving in silent prayer. Five minutes—six. The ground man was arguing with two pilots down the line. An old Douglas was ticking over.

The ground man was cursing the pilots, "Go up there, damn you! You can lead them down!"

"Like hell we could. There isn't a chance in ten thousand of us finding our way back. For us to commit suicide wouldn't help that transport any!"

Harde made up his mind then. He spun the ground man around. "I'm going up, mister. I'm going up and lead them down." Even as he said the words, Harde felt that sickness attack him. He felt his hands tremble with that strange fear, and he fought it back. Sykes was up there waiting for him, trusting him.

The ground man growled, "Who the hell are you? You can't fly this fog. You don't know——"

"I'm Calvin Harde," Harde bit out, "the man who lost his nerve in Hollywood—the man who crashed Sykes in the first place. Go tell the dispatcher to radio them to pick me up at a thousand feet and follow me in!"

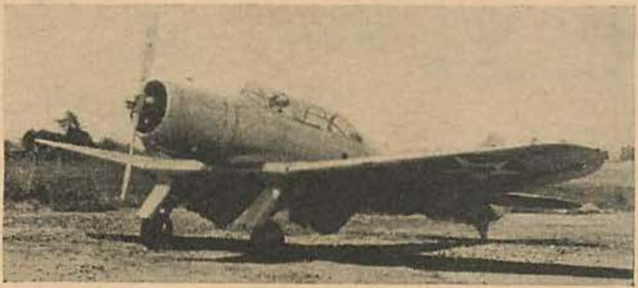
Harde scrambled into the Douglas. He fought back the instinctive fear that clung to him. He had to do this for Sykes. He might kill himself, but he owed Sykes this chance. He gunned the Curtiss motor and kicked off the brakes. He measured the field with his eyes and got the hangars and office building and transmission lines fixed in his mind. Then he was leaping up—up—up!

The fog was like feathers, swallowing him, smothering him. He shook the mist from his eyes, studied his instruments. He tried to hold his hands steady—tried to keep from turning yellow.

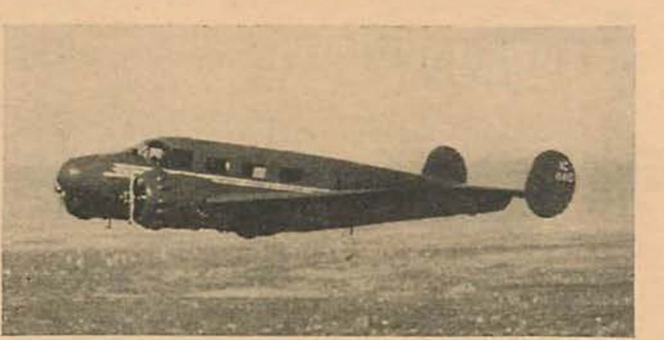
Up—up! Five hundred feet—seven hundred! He circled precisely. He tried to catch the *(Turn to page 86)*

AIR TRAILS GALLERY

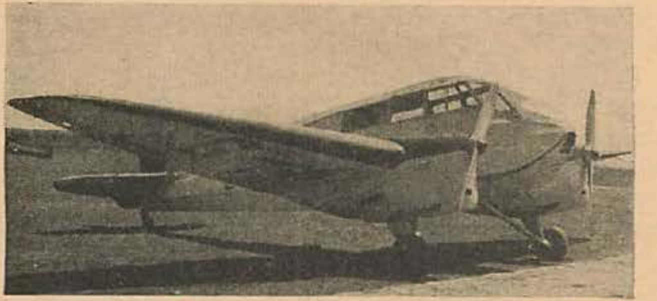
A Picture Page of Modern Planes for the Collector



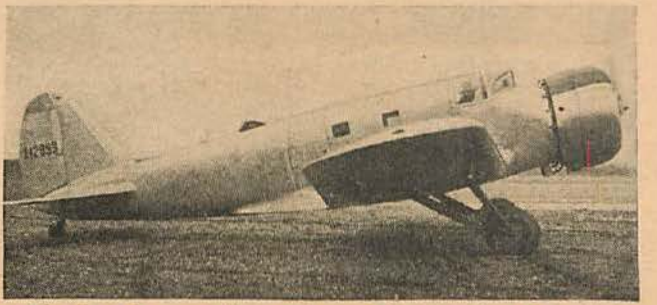
Navy Northrop Dive Bomber BT-1 powered by 750 h.p. Twin Wasp Junior, is intended for carrier operation and features a distinctive retracting landing gear.



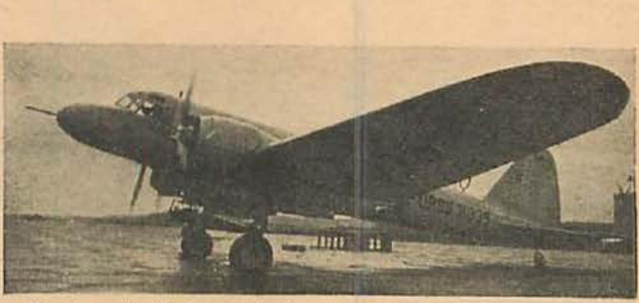
New all-metal Beechcraft 18, powered by 2 Wright 420 h.p. engines, is 8 place, and cruises at 167 m.p.h. Span is 47 feet 8 inches.



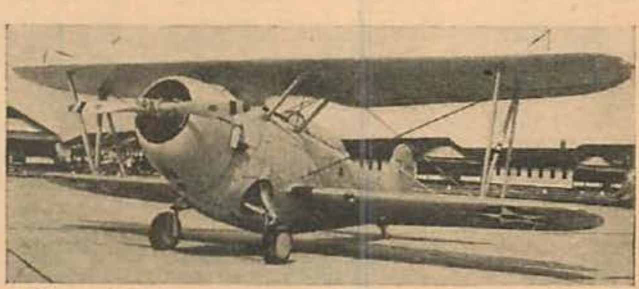
Monospar light transport illustrates novel English practice. T-shaped frame forms backbone of fuselage and wings. Engines are De Haviland 125 h.p. Majors.



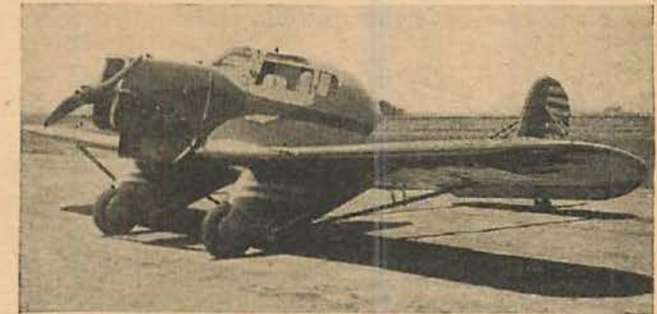
Lambert-Breese all-metal special monoplane is powered by Wasp Junior of 420 h.p.



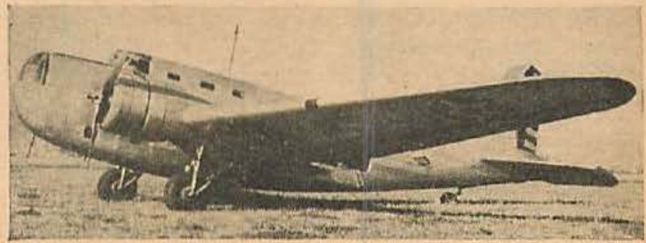
Russian A. N. T. 25 high-speed, 10-passenger transport, cruises about 200 m.p.h., and is equipped with radio and complete instrument installation. Span is 81 feet.



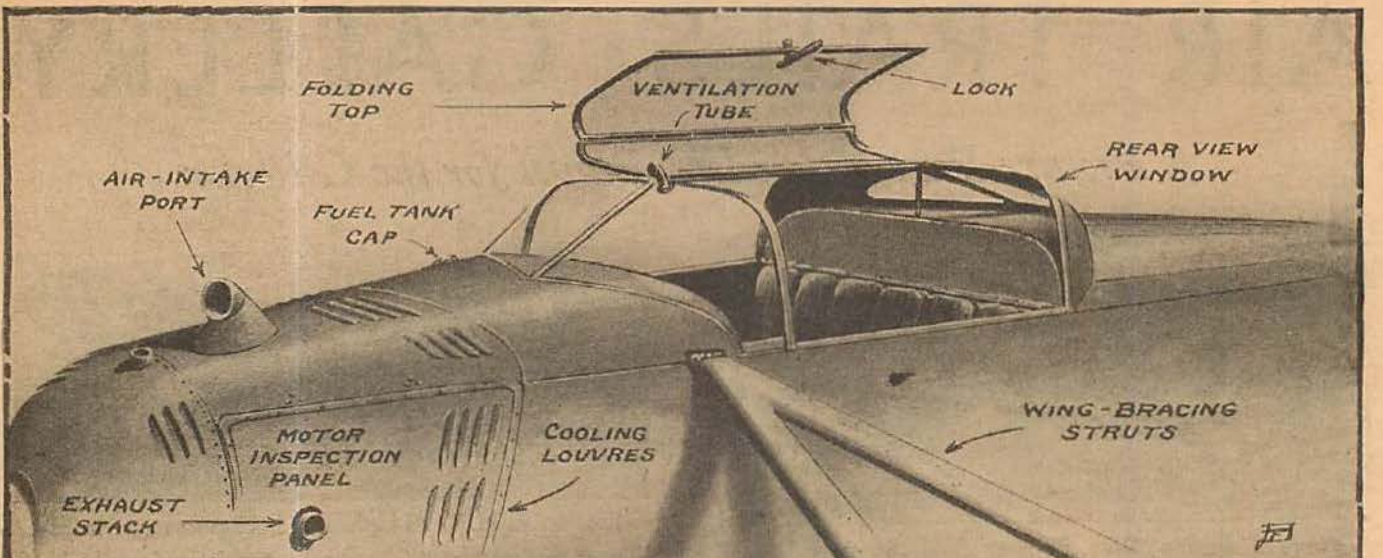
Great Lakes navy Dive Bomber XB2G-1 has tapered wings and inclosed bomb bay. Engine is 700 h.p. Twin Wasp Junior.



McGaffy experimental sport plane utilizes Ford 82 h.p. V-8 motor and 1935 radiator shell. Profile of fuselage suggests automobile body lines.



Twin-engined Douglas BB-1, an adaptation of the transport, has internal bomb stowage with 1,000 h.p. Wright Cyclones. The army has ordered 90.



Close-up drawing of the Arrow illustrates the wide, roomy cockpit and its transparent, hinged cover.

The Automobile Engine Takes to the Air

Which concerns the plane on the cover

by Frank Tinsley

HOW MANY PEOPLE are there in this great land of ours whose secret dreams carry them up into the wonderland of cloud banks and heavenly blue that we call the sky? How many boys and girls, men and women, all fledglings of the spirit, have sat in the pilot's seat of imagination and lifted their dream ships in flights of fancy?

There must be millions of us who look forward with bright hopes to a day when we, too, will take off and fly on more solid wings than those of our dream planes. Millions of us who vision ourselves climbing with a proud feeling of proprietorship into the cockpit of a sleek, shining airplane and taking off with practiced ease into the bright-blue sky.

Yet our dreams are dismissed as idle and our enthusiasm mocked as juvenile by those earthbound creatures whose greatest boast lies in their ability to "keep both feet on the ground." Incapable of understanding the urge toward the undiscovered and unknown, they mouth with relish the words of frustration: "Impractical"—"inexpedient"—"impossible." Let us see how "impossible" is the achievement of our dreams. Let us come down to earth and meet these croakers on their own solid ground. We will examine the evidence and see just how much chance you and I have to own our own planes and fly them.

Two of the barriers which must be cleared away before flying can become general are danger and expense. The average airplane still requires skill to handle. Yet when our governmental agencies undertake a campaign to develop safer, more easily operated aircraft, they are attacked by the very people who stand to profit most by a widened public interest in flying.

Despite the gibes of certain manufacturers and their trade-journal satellites, the bureau of aeronautics in Washington has stuck doggedly to the task of developing safety in aircraft design. To date, it has tested and approved a number of ships, some conventional, some unusual, which are indisputably easier and safer to fly than most of our standard planes.

In addition to this, they have worked on several projects which aim at lowering the cost of buying and operating a plane. Admitting at the outset that the much discussed $700 planes could only be achieved by mass production, the bureau initiated a study of manufacturing costs in order to discover just what made airplanes expensive.

Manufacturers were running a small-production industry efficiently and their figures proved it. Mr. Vidal of the department of commerce agreed with their claims and went on studying figures. He observed that the engines of these planes accounted for a large part of the cost. Naturally, if Mr. Vidal could suggest a way to put aircraft engines into quantity production, the manufacturers would be able to lower prices—and would be glad to pick up the incidental profit. Mr. Vidal murmured politely that such a happy state would undoubtedly come to pass, in time. However, he was interested at the moment in finding a cheap power plant—now!

"Was it possible," he inquired, "that nice, inexpensive automobile engines like the Ford, Chevrolet and Plymouth could be adapted to airplane use?"

Out in Lincoln, Nebraska, lives a man named Mark Woods. He runs the Arrow Aircraft Corp., one of the oldest manufacturers of light sport planes in the country. Mr. Woods never took much stock in the word "impossible," and, becoming actively interested in Vidal's idea, he got in touch with one David E. Anderson of Detroit. Mr. Anderson had been largely responsible for the creation of the Ford V-8 engine and is the chief engineer of the Bohn Aluminium Co. Who could be better fitted for the job of lightening Henry Ford's pet to practical airplane weight. Mr. Anderson hopped out to Lincoln, and went to work as consulting engineer for the Arrow Corp.

The principal difficulty in adapting an automobile engine to aircraft use is that its excessive weight cuts down performance to an alarming degree. The problem was to reduce the extra poundage wherever possible by the substitution of aluminium for steel. At the same time he must avoid a too drastic adaptation, for this meant losing the advantage of using standard Ford parts for cheap replacement and repair.

His compromise solution consists of replacing the regular oil pan with one of aluminium, installing a lighter generator and substituting a 2-to-1 reduction gear for the flywheel. The balance of the Ford V-8 motor is retained as originally manufactured with the exception of the aluminium pistons. This improvement, though not necessary, follows usual aviation practice. The engine itself being unaltered, repairs can be handled by regular Ford dealers at Ford prices.

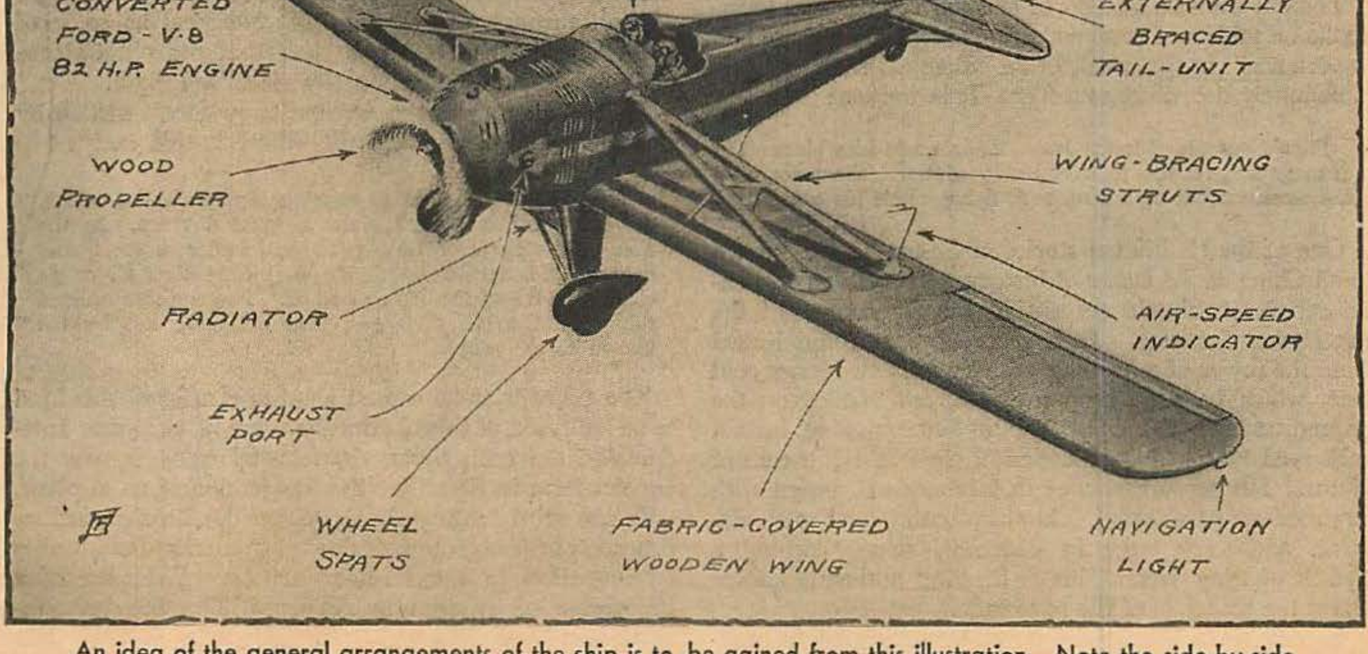
In place of an expensive top overhaul, Arrow owners merely have the special parts removed and exchange the old block for a factory-rebuilt motor at a total-installed cost of less than seventy-five dollars. The entire job can be completed in less than half a day at any Ford service station.

The motor is mounted "rear-end-to" on conventional steel-tube trusses and is held by its normal supports. Removal of the cowling permits complete access to both banks of cylinders as well as the distributor, special water pump and special generator. The gear case is bolted to the front—normally the back—end of the engine. The water-header tank is mounted high up in the front of the motor compartment, with a filler tube protruding slightly through the top of the cowling. A rectangular radiator is slung beneath the fuselage between the Vees of the landing gear, where it causes the least possible air resistance.

As used in the Arrow Sport, the V-8 motor develops 82 h.p. at 3,075 r.p.m. and weighs 402 pounds. The gear ratio is 1 to 1.95, so that the prop r.p.ms. are reduced to 1,580. "Two-engined reliability" is claimed for the motor, due to the fact that if either set of distributor points on the single ignition system become so worn that they do not fire, they overload the other set and assure positive firing on one bank of cylinders. In this condition, the engine still revs 2,800, and develops enough power to maintain flight. Another useful characteristic is that, being a typical Ford motor, it runs well when boiling furiously. In fact, it has all the advantages of a supercharger for taking off. If a burst of power is needed to get out of a small field, the radiator is blanked off until the engine boils. Then, with the blank pulled free, the take-off is made at once. Once in the air, the motor cools down and loses the extra horsepower.

Unusually easy starting is a feature that will be appreciated by Arrow pilots. The prop turns left-handed and starts on the first or second pull. The cruising rate of 3,075 r.p.m. drags the plane along at

(Turn to page 95)



An idea of the general arrangements of the ship is to be gained from this illustration. Note the side-by-side seating and attractive design.

EARLY and STRANGE CONCEPTIONS of FLIGHT

by Lieut. Com.
GEO. O. NOVILLE U.S.N.R.

IN ANY DISCUSSION regarding the conception of air craft, usually the names of Lilienthal, Alexander Graham Bell, and the Wrights predominate. Occasionally the name of Leonardo da Vinci will be mentioned and sometimes given credit for first explaining the possibility of heavier-than-air flight. However, recent research has uncovered the fact that the Chinese emperor, Shun, who lived in the third millennium before our era, approximately 2258-2208 B. C., is the first flier of record in history and is also recorded as the first man who made a successful descent in a unit based on the principle of the parachute.

Between this first successful descent many, many centuries intervened before the experiment was repeated in the midst of our civilization in 1783 A. D.

The old Chinese method of keeping records was to inscribe on tablets of bamboo various incidents of note and importance. In the annals of the "Bamboo Books," Shun is definitely described as a flier. It is written:

> Shun's parents detested him. They made him plaster a granary and set fire to it at its foundation. Shun donned the work clothes of a bird, and, flying, made his escape.

One of the traditional stories of Se-ma Ts'ien, known to all China as the father of history, sets forth an authentic report of Shun's descent in the forerunner of the parachute of to-day. It is recorded that Shun leaped from the tower of a burning granary with two large reed hats, which he used as parachutes, and landed on the ground, unhurt and safe. This is quite possible, in that such reed hats in the collection of the Field Museum of Natural History are similar in fundamental design with our modern parachute. They are umbrella-shaped, circular, and very large in diameter, some reaching a stretch of three feet. This is the first authentic known use of the principle of the parachute.

Leonardo da Vinci, who never actually made a parachute descent, is credited, however, with conceiving the idea of the parachute as follows:

> If a man have a tent roofed of calked linen twelve yards broad and as many yards high, he will be able to let himself fall from any great height without danger to himself.

Da Vinci promulgated this theory between the years of 1452-1519. However, note that this was merely a theory and was not based on known tests and experiments, and there is a great difference between Leonardo da Vinci and Shun—Da Vinci being merely the author of a theory, while Shun actually performed the descent. It is a matter of record that the first real descent in a parachute was not made until Lenormand successfully "bailed out" from an observatory at Montpelier, France, in 1783.

In a great many of the written records of the old Chinese dynasties many references are made to the flight of man through the clouds. Mythological as some of these legends may be, it is clear that the old Chinese philosophers and students really visualized flight.

In the "History of the Ancient Emperors," written by Huang-fu Mi—215-383 A. D.—there is this entry:

> Ki-kung-shi was able to make a flying chariot which, driven by a fair wind, traveled a great distance. At the time of the Emperor Ch'eng T'ang, founder of the Shang dynasty, it is recorded that the west wind blew Ki-kung's chariot as far as the Ho-nan River. The emperor ordered this chariot to be destroyed, that it should not become known to the people.

Ten years later he caused another chariot of this kind to be built, but of this chariot there are no records. Incidentally, the term flying chariot (fei ch'o) is now the current term in China for the designation of an airplane.

In the third century A. D., Chang Hua makes further mention of the invention of the flying chariot, but ascribes its invention to the Ki-kung nation. Evidence of a knowledge of aviation in Ancient China has been investigated by Professor H. A. Giles, who in 1910 published a treatise on "Traces of Aviation in Ancient China."

(Turn to page 95)

What's Your Question?

By CLYDE PANGBORN

Wing Commander

As soon as possible after the questions are received, the Wing Commander of the Air Adventurers will answer on this page such questions as appear to be of general interest to our members.

Question: I have been most interested in the Pitcairn Roadable Autogiro and wonder if I could get a complete set of blue prints on the machine so that I could make one myself. I have made model planes and several motor boats and have a small machine shop where I believe I could turn out the parts. J. J. F., Morganton, N. C.

Answer: Your letter is most interesting, but I question whether the Pitcairn Co., after spending so much money to develop the Roadable-Giro, would care to turn over a complete set of blue prints for some one to build for themselves. However, why not write to the Pitcairn Autogiro Co., Pitcairn Field, Willow Grove, Pa., and see what they think of the idea?

Question: Where can I purchase plans or a book on building the "Flying Flea," and how much would it cost to build? W. D. W., Drayton, S. C.

Answer: Blue prints on the *Flying Flea* may be purchased at the SuperFlea Aircraft Corp. of Lawrence, Kansas. The price is $5.00, I believe. The cost of building depends on how much of the actual work you can do yourself and the prices of material in your section.

Question: What is meant by balanced ailerons and balanced rudders? W. H., LaCrosse, Wis.

Answer: Balanced controls, whether they be ailerons, elevators or rudders, are movable surfaces in which a small portion of the surface protrudes over the edge of the hinge or pivot line. They were very popular during the War days, and excellent examples may be seen in studying the Fokker types of that time. The Fokker D-7 is a particularly good example of a machine with balanced controls. It will be noticed that all movable surfaces have a small portion of their area jutting over the hinge line. It was so designed to make the movement of the controls easier.

Question: Can you tell me what a 9-G dive actually is? T. S., Peoria, Ill.

Answer: The 9-G dive is the severest test put to military planes. Actually, it means a dive of such speed that will register a pull of nine times the pull of gravity on the plane on an accelerometer. For instance a machine in normal level flight will register 1-G on the accelerometer, and if a test pilot takes a plane up to, say, 10,000 feet and noses it down at its greatest possible speed and then suddenly pulls the stick back, the accelerometer will register the number of Gs in the pull-out. Nine Gs usually represent the force of a pull-out after a terminal velocity dive, and indicates that the pilot has forced the ship to the limit. If it stays together after that, it has passed a 9-G dive.

Question: What is used in making smoke for sky writing? P. C., Los Angeles, California.

Answer: You are treading on sacred ground now. There is no set formula for the chemicals used in sky writing. The men in the business concoct their own mixtures and have various formulæ for various colors. But, they are all professional secrets. It is known, however, that white phosphorous and titanium tetrachloride are used.

Question: What were the "flaming onions" so often mentioned in war-time accounts of antiaircraft fire? N. F., Southbridge, Mass.

Answer: The "flaming onion" was a form of projectile fired from a large-caliber gun. It was an incendiary projectile assembled in the old chain-shot manner. Usually the projectile took the form of three phosphorous-covered balls chained together. On discharge these balls were ignited and hurled skyward toward their target. Their strange manner of flight, their greenish color and their somewhat startling appearance won them the name "flaming onion." There is no record of any ever hitting a plane, however.

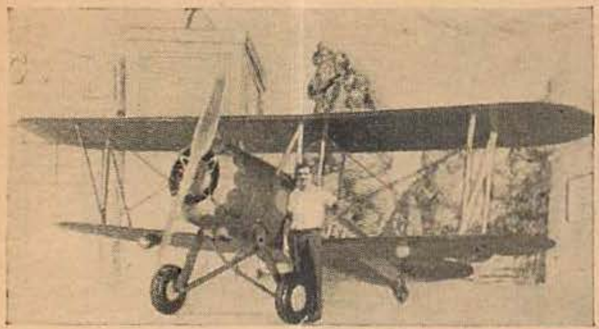
Question: Would it be possible to build a triple-row radial engine, and is an X-type engine out of the question? F. L., Chicago, Ill.

Answer: The great problem in building a three-row radial engine would be to devise a system for cooling the middle row of cylinders. The same problem came up when the two-row radial was first built, but it was overcome by careful cowling design, which directs a flow of air around all cylinders. You can see how this problem would be increased in a three-row job. X-type engines have been built in the past, but they are not particularly suited for good streamline design. A better form is the H-type, such as the Halford-Napier *Dagger* and the promised American Ranger H-type engine.

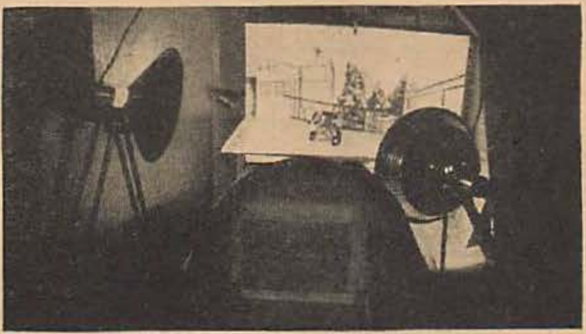
TRICK Photography

by HENRY CLARK

A new, fascinating hobby for model builders—adaptable to many subjects and novel ideas.



Above: A finished picture which, until given very close inspection, gives the impression of a man beside a full-sized airplane.



Right: The lights and camera focused on the model and subject—showing their actual size.

ORDINARILY, a picture is no novelty. Everybody shows everybody else snaps of his activities and each tries to look interested. But there is a way to make your pictures fascinating, and to "autograph" them in an unusual manner.

This technique may be varied to suit any subject, but this article will discuss only its use in conjunction with models.

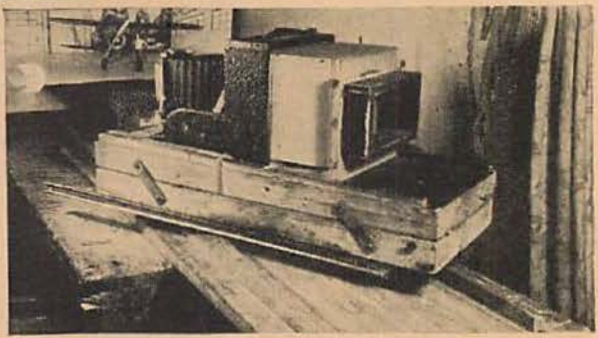
Photography is rapidly becoming a part of model-building activities. A photographic file is considered quite necessary by our more advanced builders.

When you take these photographs, it is just as easy to make them fascinating by apparently posing beside your model, leaning against it, standing with one hand on the cowl, or in some other manner so startling that every one who sees it will be interested.

The method of accomplishing this effect is quite simple, if you follow instructions. And having accomplished good results on a few pictures of this sort, you can proceed to adapt this method to any other type of subject if you wish.

The job is best done with a folding type of camera, the type which has a track for the bellows to slide on. Any good lens will serve. Open and detach the back of the camera. Lay the camera on a length of board about eight inches wide and twenty-four inches long, as illustrated.

Attach a box of heavy cardboard to the opened back of the camera. The box must be of the same proportions as the back of the camera, and about five inches long. Then attach a small oblong of one-half-inch wood to the back of the box, as shown in the illustration. This wood is used to accommodate the open film compartment of your camera. The opening must be of the same dimensions as the opening of the film compartment.

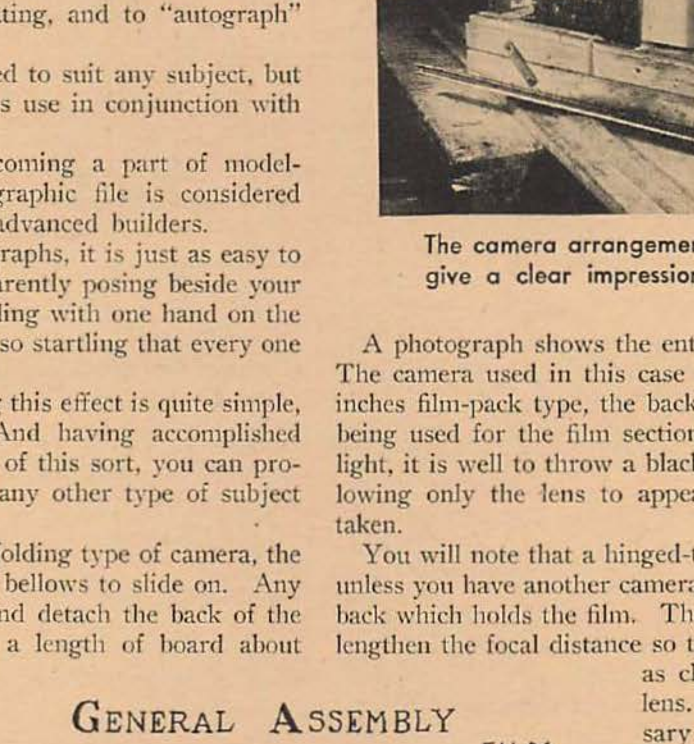


The camera arrangement photographed to give a clear impression of its mechanics.

A photograph shows the entire arrangement in detail. The camera used in this case is the four inches by five inches film-pack type, the back of a folding-type camera being used for the film section. For protection against light, it is well to throw a black cloth over the whole, allowing only the lens to appear while the pictures are taken.

You will note that a hinged-type camera will not serve unless you have another camera from which to detach the back which holds the film. The extension box is used to lengthen the focal distance so that pictures may be taken as close as one foot from the lens. This extension is necessary in order to make the model fill the entire film area and not appear as a small object in the center of the film.

Secure a picture of yourself, posed in the manner in which you want to appear with your model. You must be sure that your figure on the picture is proportionately right in size, considering the model as a full-sized plane. Cut carefully around the outline of your figure—the



This diagram contains all the necessary information for the trick photographer. Study it.

(Turn to page 93)

CROSS WINDS

Can you answer the aeronautical definitions in this puzzle?

1	2	3	▨	4	5		6	7	▨	8	9	10
11			12			▨	13		14			
15					▨	16						
▨	17			▨	18		▨	▨	19			▨
20			▨	21			22	23	▨	24		25
26			▨	27					28	▨	29	
	▨	30	31			▨	32			33	▨	
34	35	▨	36			37			▨	38	39	
40		41	▨	42					▨	43		
▨	44		45	▨	▨	46		▨	47			▨
48				49	50		▨	51				52
53						▨	54					
55			▨	56					▨	57		

ACROSS

1—Three fourths of earth's surface
4—Type of British Wolseley aero engine; also a group of stars pictured as a ram
8—Frozen water
11—Air-slang term for anti-aircraft gun
13—To blush
15—Fixed in time.
16—Structure inclosing parts of aircraft, such as engine
17—Misdeed
18—Compass direction between east and south
19—Wet
20—Nickname for lion
21—Type of military airplane used in reconnoitering
24—Drink in small quantities
26—Vase with pedestal
27—Powerful type of gun, sometimes used in aircraft
29—Abbreviation designating right-hand side of bookkeeper's accounts
30—Mark left by a wound
32—Make of French plane, as known by initials of company's name
34—First person singular of "to be"
36—Thin flat pieces
38—Noun suffix denoting one who does or practices
40—Steal
42—A hard, dark wood
43—Permit
44—Measure of length equal to 5½ yards
46—Abbreviation for heaviness
47—Latin term for "air" appearing in many aeronautical words
48—Make of Russian commercial plane
51—Stuck in mud
53—Kind of Lockheed plane
54—Smooth areas in front of hangars
55—Affirmative reply
56—Kind of British Blackburn flying boat
57—Balloon mesh supporting basket

DOWN

1—Sorrowful
2—That which rubs out
3—Military combats
4—Assist
5—Concerning
6—Epoch
7—Dry
8—Of aero engines: runs at minimum power
9—Irish
10—Compass direction between northeast and east
12—Female chicken
14—Atmospheric moisture condensed on cool surfaces
16—Gaseous element found in the air
18—Kind of Warner aero engine
20—Pertaining to the moon
21—Proportion between model plan and the actual airplane
22—Not delivered
23—This goes before turvy
25—First word in name of manufacturer of Hornet and Wasp engines
28—Letters indicating nationality and type of license of American commercial airplanes
31—Initials of Air Adventurers' wing commander
33—Movable portion of airplane wing controlling lateral balance
35—Mental attitude
37—Closely populated place
39—Tranquil
41—Connecting pins threaded to receive nuts for fastening
45—Prefix meaning through or across
47—Most necessary thing for flying
48—Producer of British gyroplane with powered rotors
49—Bite
50—Anger
51—Abbreviation of usual measurement of aircraft speed
52—Type designation of Douglas sleeper plane
54—Preposition denoting location

CROSS WINDS

Answers for April

F	I	R	E	F	L	Y	▨	A	P	R	O	N	S
I	▨	A	G	R	E	E	▨	R	A	I	D	▨	Z
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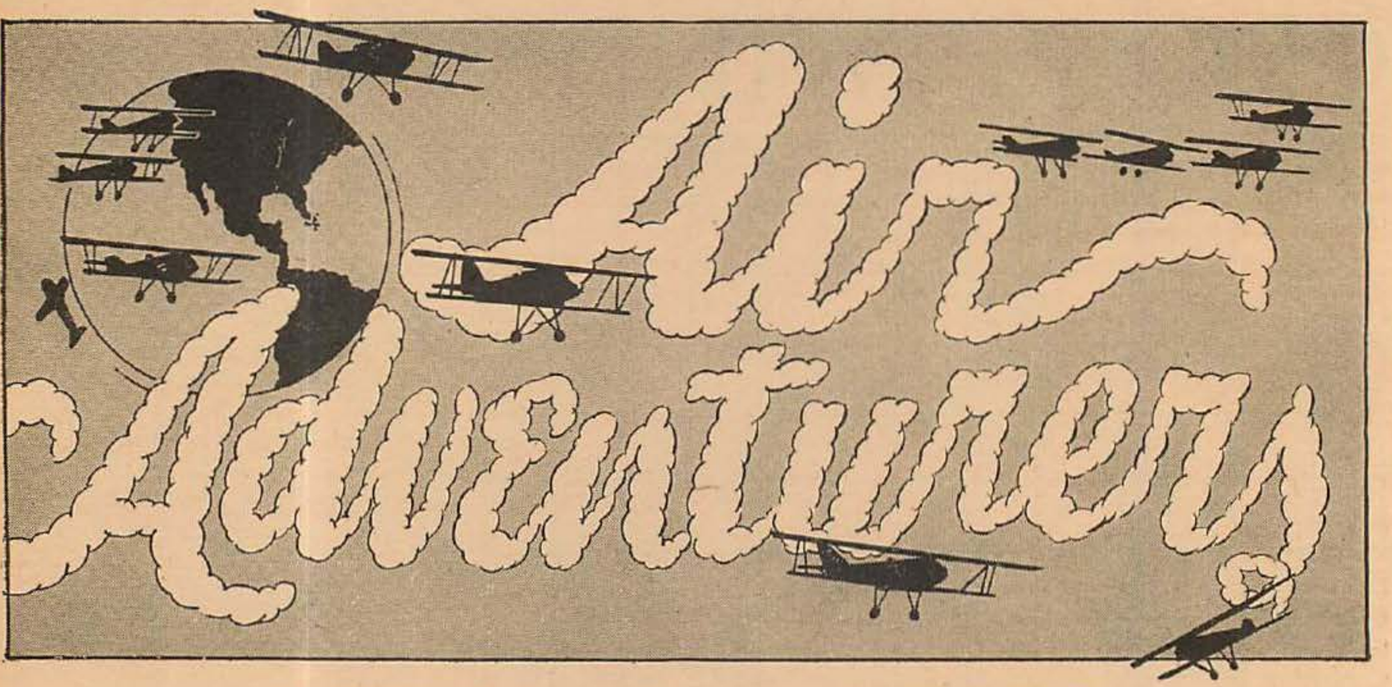


GREETINGS, AIR ADVENTURERS!

GREETINGS, Air Adventurers!

First, our sincerest thanks and our heartiest welcome to old and new members. You have all stepped forward loyally this past month. Never in the history of Air Adventurers have we enjoyed such an overwhelming flood of membership applications or responses to our new award system.

For the next few months the staff handling the all-important Air Adventurers' Club business will be busy checking the hundreds of examination papers and sending out the official awards, which will, in turn, make you eligible for the more advanced ranks and awards. Those of you who are not members of this great organization are advised to send in your application coupon as soon as possible, so that your name can be added to the rolls.

But first we want to go into the Creed once more. Do not clip that coupon until you have thoroughly digested the true meaning of the Air Adventurers' Creed. Do not enter into this organization light-heartedly or for the sake of a badge. The Creed demands more than that. There is too much hard work ahead, and when we say that we remind you once again of the seven points that make up the Creed: self-reliance; courage; initiative; loyalty; integrity; independence; obedience.

The Air Adventurers are not plunging blindly forward on a mad wave of emotional enthusiasm. We are not "following the crowd" that chooses the line of least resistance. There is plenty of resistance ahead. We are not "badgers" and flag wavers because that is the thing to do. We are Air Adventurers first of all because every Air Adventurer has sworn to do his best to further the general advancement of aviation.

Remember that one point when you clip the coupon across the page. We are out to further the general advancement of aviation. And the man who tackles that task in this year of 1937 has really taken on something.

The Wrights are the fathers of artificial flight, and no one can take that honor from them. The rest of the names that passed through air history into the mad Great War period have their place in the scheme of things. Since the War a new band of aerial crusaders came up. It included Lindbergh, Kingsford-Smith, James Mollison, Amelia Earhart, Dieudonne Coste, Maurice Bellonte, Dr. Hugo Eckener and hundreds of others who carried aviation up the heavy going until it reached the glorious peak encountered in 1936.

But what of 1937?

When air history is written fifty years from now, some one will say, "The future of aviation hung in the balance in 1937, for it seemed that the ultimate in speed had been reached, but with speed came disaster, and the world sat back and wondered. All the great plans for to-day's glorious aerial transportation systems were laid and ready for operation, but the world had lost hope, confidence, and loyalty to a glorious tradition. Vast fortunes invested in aviation were swept away overnight in a flood of international distrust. No longer did they raise their eyes to the skies, for the canker of fear had done something inside that caused them to walk with a stoop, and they saw only earthy things.

"But then, out of the crowd stepped a new breed of air adventurers who walked with springy stride, their heads up and their eyes shining with a new hope. They had courage, self-reliance, initiative and loyalty to the great science of aviation. The others stepped aside, glad to relinquish the load. It was taken up, and aviation swept forward again to the glorious peak it enjoys today."

That historian will use the words "air adventurers," but it is up to you whether he writes it with capital letters—Air Adventurers!

This is one of the great crisis periods of aviation. How far the industry goes on remains with the youth of the world—the Air Adventurers of the world.

We all know what setbacks aviation has faced all over the world. There is no need to enumerate them or attempt to place the blame. America has suffered. Great Britain and her colonies have suffered. France has lost many fine airmen and many splendid planes. A great designer was lost to Spain. Splendid military types both here and abroad disclose startling faults in manufacture.

More crashes—mysterious crashes—and the fatality chart graph rises.

The critics point with scorn. The scoffers have a field day. The man who had hope tries to understand, but amid the distorted publicity—the frantic joust to present the picture at its worst—he turns away and waits to see what the future has in store. Only men with the spirit of Air Adventurers can save a situation of this kind, and promise a future.

But it cannot be a stop-gap, temporary salvation. This time it must take the form of a sturdy defense that will not be denied. First we must know what has been going on and what it takes to stop it. Air Adventurers will not be ignorant of the limitations of flight, nor the problems of power. We will not go up and down the land shouting, but we will show the unbelievers cold facts, hard truths and build up the waning confidence.

Now will you clip that coupon? Can you take over the burden of the Creed, or are you just a badge wearer?

You must prepare yourself for this great future. This is not war in the sense of conflict. There are no trenches in which to take cover, no funk holes when the shelling gets hot. There is no barbed wire to slow up the attack. You have to stand out in the open and hand it out.

Your strength is knowledge, the keenest weapon in the world. Knowledge will overcome ignorance, the stumbling block in the path of aviation. You must prepare yourself for this future, or you will be swept out of the play in the first rush.

We of Air Trails will do our part if you will do yours. We have given what we believe to be the best in aviation articles and features. We are out for the truth, even though, at times, the truth may be hard to accept, but we believe in the future of aviation.

These are serious times, and Air Adventurers all over the world must coöperate. We must have your loyalty, courage and integrity. Membership does not necessarily mean a program of good times. The model does not always fly the first time. It takes hard, persevering work and—knowledge.

As you progress in rank and craftsmanship awards, you will be able to talk aviation in a more convincing manner. You must gather your facts and present them in their proper light. You must state these facts to the man who is not convinced. It is not sufficient to keep saying: "Aviation and flying is safe." You have to prove to him that it is. You must show him that out of every million passenger miles flown, the ratio of safety is high compared with other forms of travel.

You must know your types and for what they were designed. You must know their limitations, their tankage and radius of action. Your comparisons must be fair. You wouldn't attempt to compare the performance of an East River tug with one of Uncle Sam's destroyers, and you wouldn't expect one to do the work of the other. The same goes in aviation, only more so. When your critic compares a certain American or French fighter with another ship, first be certain of your facts and then show him that an intercepter is not a pursuit ship, or that plane "A" was designed for a certain job and not for speed, or distance, as the case may be. It is ignorance of this kind that makes misunderstandings and often leads to further loss of confidence.

If you compare commercial planes, first remember the type of country they fly over and the required distance in hops. Are they multi-motored ships, and how many passengers and how much freight do they carry? What is the power of the engines, and how long can they stay in the air in an emergency? What radio and navigation equipment do they carry, and what factor of safety do they boast?

All these and a thousand more points must be digested before you can go out and talk aviation. But that's your job, Air Adventurers. You must know, and then you must have the courage of your convictions and the loyalty to aviation to go out and talk it. Later on you will want to get into the business, and if you are not prepared you have no chance. You must not expect to pick up a complete aviation profession out of Air Adventurers. We do not pretend to any such miracle. But, you can get a thorough grounding in aviation that will make you a more pliable and suitable student when you go farther afield and actually take your professional course later on.

What you will get out of the Air Adventurers depends on yourself. You will get more than you put into it, we can assure you of that. But the Creed is your answer, if you can live up to it. You have sworn to further the general advancement of aviation, and there is no greater job in the world to-day. Every boost you give aviation is a boost for your own future.

This is 1937, and you will never forget it.

Your Flight Commander,

Albert J. Carlson

THE HONOR ROLL FOR MAY

CRAFTSMAN AWARDS

Topographer

Jerome W. Cowan, Chicago, Ill. John Daly, Utica, N. Y.
MacDuncan, Asheville, N. C.

Observer

Francis Rogers, Hingham, Mass. Frank Kotacka, Fords, N. J.
Bernard Rosenberg, Bronx, N. Y. Albin Boyersz, Evanston, Ill.
John Vopat, Jr., Garfield Hts., Ohio.

Photographer

Eugene Coons, Pontiac, Mich. Walter Badger, Chicago, Ill.
Robert Neeley, Chicago, Ill. Antoni Sobieralski, Seattle, Wash.
Donald Geery, Garden City, L. I., N. Y.
Cliff E. Chamberlain, Clarinda, Iowa
Aldrich Foucek, Binghamton, N. Y.

Airplane Mechanic

Robert Cammann, Baldwin, N. Y. Billy Craft, Greenwood, Ind.

(MEMBERSHIP COUPON)

To the Flight Commander, Air Adventurers,
79-89 Seventh Avenue,
New York, N. Y.

I am interested in aviation and its future developments. To the best of my ability I pledge myself to support the principles and ideals of AIR ADVENTURERS and will do all in my power to further the advance of aviation.

Please enroll me as a member of AIR ADVENTURERS and send me my certificate and badge. I enclose ten cents to cover postage.

Name .... **Age** ....

Address ....

....

☐ **Check here if interested in model building.**

(This coupon may not be used after June 15, 1937.)

The MODEL SHOP

14 Model Items

Spring Fever .... *by Gordon S. Light* 40
Which concerns the model workshop, and seasonal problems.

The Contest Calendar 40
A schedule of competitive events which keeps Air Trails readers up to the minute.

Flight-Testing Gas Models .... *by Francis Tlush* 41
A necessary article for builders of gas-powered models. There will be trophy plans next month.

The Stout Trophy Winner
by Gordon S. Light and Ervin Leshner 42
The complete flying plans for the outdoor fuselage model which won the 1936 competition. The 5th consecutive championship presentation in Air Trails' exclusive series.

The Discussion Corner 47
This month readers discuss, "Adjustable Pitch Propellers on Outdoor Models."

With Wheels Or Pontoons .... *by Alan D. Booton* 48
The flying scale plans of the Arrow Sport Plane, Model F—the plane on the cover.

The ? Mark 53
Answering your questions about models and model problems; interesting points for every reader.

The Insuror 54
A beginner's stick model with a bow frame; a fascinating pusher type that flies well

Model Matters 57
Club notes, model activities everywhere, news of recent contests, pictures. This is YOUR page. Send in your notes, snaps, news.

Popular Sport Plane .... *by William Winter* 58
A solid ¼" scale model of the "Taylor Cub"; a handsome addition to the modern collection.

Indoor Equipment .... *by Lawrence N. Smithline* 60
Practical methods for transporting delicate models safely; you need this information.

Builder's Guide .... *by William Winter* 61
The fifth in the construction series. This month the subject is wings.

Balsa Strength Testing Machine .... *by Howard Ide* 62
An ingenious and wise addition to the wide-awake modeler's equipment.

The "Tipsy S" .... *by Burton Kemp* 63
A popular Belgian light sport plane which has attracted wide attention. Solid ¼" scale plans.

Spring Fever

by Gordon S. Light

SPRING is here and every modeler is suffering from spring fever. Open the workshop window and take a deep breath of the spring air. And if you can still resist the urge to get outdoors and do some model flying you certainly don't qualify as a model builder. Even the models in the workshop window rustle in the breeze, as though they were anxious to get off on a good flight. And the balsa shavings and tissue scraps move across the workbench as though they were alive.

Spring weather was made for model builders. It assures them a steady run of good modeling weather—a mighty pleasant relief from winter. The warm weather thaws out the hardy builders who have been carrying on during the cold weather. And, in addition, it brings out hundreds of other builders. Together they pry the lid off the summer modeling season.

But there are certain phases of spring model flying that prove annoying—even worse than the April showers or the gusty spring air. One of the annoyances is the great number of people who take advantage of the spring weather to play baseball, drive golf balls, or to play in a variety of other games. During the winter we had undisputed possession of the park, with no restrictions on our flying. But in the spring the model builder will be the first to suffer from the cramped conditions of the parks. So keep your fingers crossed if you fly your models in a public park.

I've had the experience of flying models under such conditions. One experience in particular stands out clearly. I had just finished a new fuselage contest model and went to the park to fly it Sunday morning. Every section of the park was crowded with some sort of activity. On each flight the model was exposed to a variety of dangers that would have grayed the hair of any modeler. Several times the model interrupted the baseball game by flying low over the diamond. The players kindly stopped the game until the model was out of danger. But the good luck could not last forever.

On the next flight a two-base hit clipped the rudder off the model, just as it (Turn to page 95)

The Contest Calendar

SUMMER CONTESTS of the Jacksonville Model Club, held under N. A. A. rules, are scheduled for the middle of June and August 15. Information from club headquarters, 2048 Roselle Street, Jacksonville, Florida.

EXHIBITION SCALE Model Contest, May 17-22. Any one in the city of Allentown, Pennsylvania, may compete for the local Berryloid Trophy. Entry blanks from 1520 Liberty Street, which is the address of the Flying Keystone Model Airplane Club, sponsors of the contest.

OUTDOOR FLYING Contest, May 16; rain, date May 23, with glider, stick, and fuselage events. Any one from the eastern part of Pennsylvania is eligible. Entry blanks and information from the address which is given directly above.

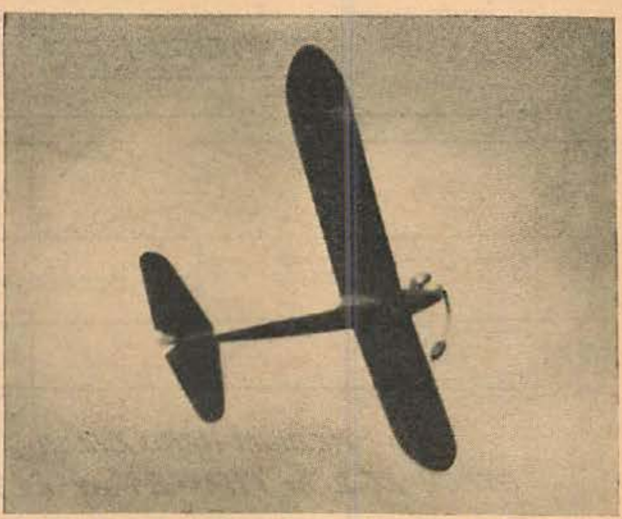
1937 EASTERN STATES Gas Model Meet. Sponsored by the Soaring Society of America, as a feature of the 8th Annual National Soaring Contest. July 5-9. Sanctioned by the N. A. A. Events include altitude, duration, and payload flights, also special events for multimotored, radio-controlled, and autogiro gas models. Trophies and cash awards. Information from Soaring Society of America, 1614 Delaware Ave., Wilmington, Delaware.

The Model Workshop asks the aid of readers and clubs in developing for their benefit a complete, detailed report of all model contests and exhibitions, large or small, everywhere. Listings should be received by The Contest Calendar, AIR TRAILS, 79 7th Ave., New York City, at least two months in advance; news of winners and results as soon as possible.

Flight-Testing GAS MODELS

Authoritative advice by the designer of the Texaco Trophy Winner

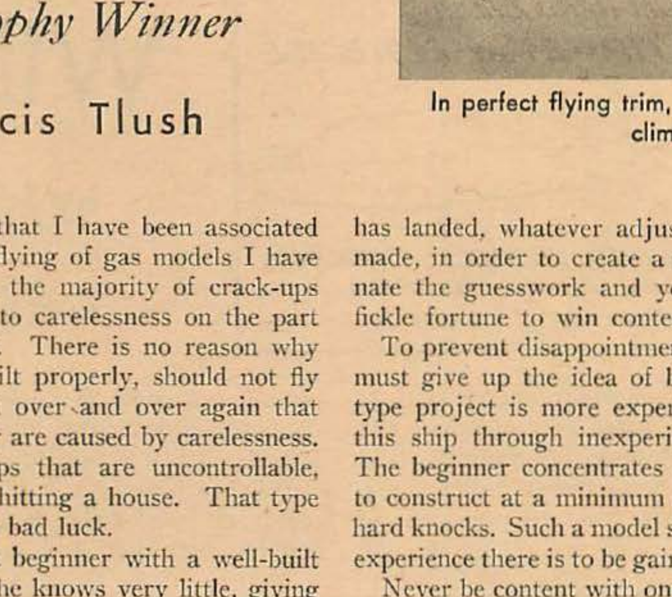
by Francis Tlush



In perfect flying trim, the ship gains altitude in a climbing turn.

DURING the few years that I have been associated with the building and flying of gas models I have become convinced that the majority of crack-ups existing at contests are due to carelessness on the part of the model builder himself. There is no reason why a model, if designed and built properly, should not fly well. Statistics have proven over and over again that accidents do not happen; they are caused by carelessness. Of course, there are mishaps that are uncontrollable, such as landing in a tree or hitting a house. That type of accident can be credited to bad luck.

It is discouraging to see a beginner with a well-built model, the balance of which he knows very little, giving the motor the gun and sending the untried ship to the junk pile. He never stops to think about adjusting and test-flying the model. Judging by appearances, beginners usually depend on "Lady Luck" herself to guide it. Sometimes, due to the element of chance, the model performs beautifully, but should it get out of adjustment after a hard landing, luck most likely will desert it on its next flight. The slipshod builder will invariably give it the gun again, without retesting, and send it to its doom.



After the take-off this beginner's ship is turning gently with the torque, already essaying the climb "upstairs."

A shameful exhibition at every contest is a builder deliberately launching his model without having tried to correct a previous erratic flight. Needless to say, the second performance is always as expected. The model *thus flown* usually spirals in full speed, and after the pieces are gathered together the only thing that remains intact is the tail. If this builder had taken time to study the faulty actions of his model, his name would undoubtedly have been listed with the prize winners.

Another foolish mistake frequently observed is a person continuously launching his model without trying to better the performance shown on previous flights.

The thing to do when testing and flying a model is to observe the flight characteristics, so that, when the model has landed, whatever adjustments are necessary can be made, in order to create a top-notch performer. Eliminate the guesswork and you won't have to depend on fickle fortune to win contests.

To prevent disappointments with your first model, you must give up the idea of building a supersoarer. This type project is more expensive and the cracking up of this ship through inexperience will hurt all the more. The beginner concentrates on a model that will be easy to construct at a minimum of expense and that will take hard knocks. Such a model should provide you with all the experience there is to be gained in the flying of gas models.

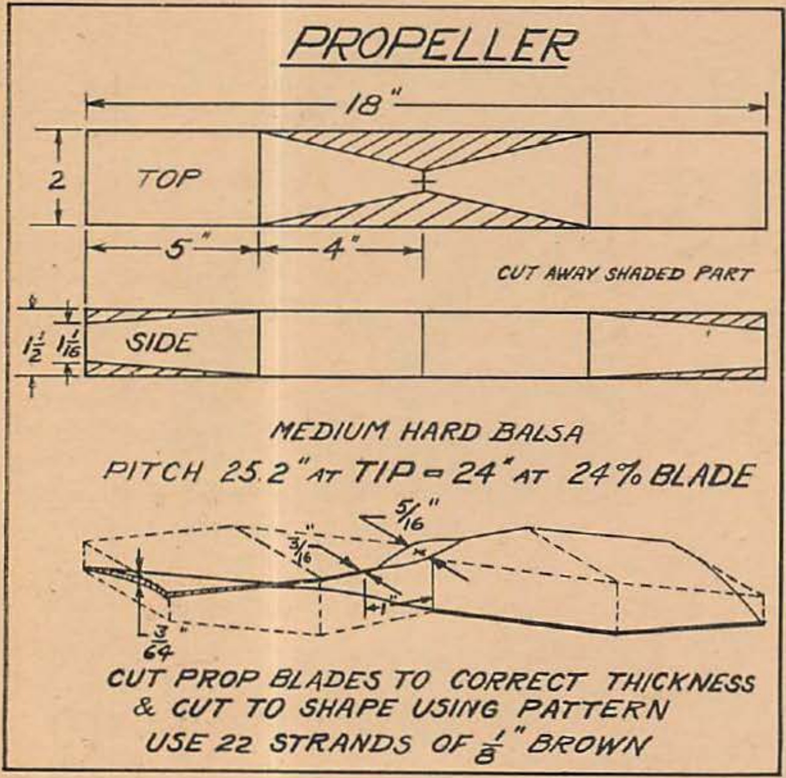
Never be content with one adjustment on your training model. By doing so, you are really learning nothing. Experiment with numerous arrangements and settings, so that various flight characteristics can be discovered. The most important objective gained by this experimenting is confidence in yourself and in your model building. The sight of your model climbing high in the sky soon becomes a common occurrence. Let your timer do all the worrying for you.

After you have gained experience and knowledge with the simple design, you can advance yourself to something more refined: not having to worry about faulty handling. Remember that a beginner's model, well flown, often proves a winner.

Confidence in your design and model can only be attained after you have made numerous flights. You become a veteran only when you are sure of your adjustments. There must not be a trace of guesswork or you are liable to become panicky at the crucial moment and spoil chances of making good flights. If your ship is built according to specifications and you have worked carefully, there is no need to be worried about the first test flight.

Adjustments should not be too sensitive, since it is difficult to maintain them in this case.

(Turn to page 91)


PROPELLER
18"
2
TOP
5"
4"
CUT AWAY SHADED PART
1½ 1/16
SIDE
MEDIUM HARD BALSA
PITCH 25.2" AT TIP = 24" AT 24% BLADE
5/16"
3/16
3/64
CUT PROP BLADES TO CORRECT THICKNESS
& CUT TO SHAPE USING PATTERN
USE 22 STRANDS OF 1/8" BROWN

The STOUT TROPHY WINNER

by Ervin Leshner and Gordon S. Light

THE STOUT TROPHY contest for outdoor fuselage models probably attracts more entrants than any other model contest. And since this contest is held only at National Contests, the best modelers in the nation compete yearly to determine who will have possession of the trophy for the coming year. Ervin Leshner was the winner in the contest held last July at Detroit. He had a nicely designed model and handled it like a veteran. The 36-minute winning flight was undoubtedly aided by a little good luck. But, in view of Ervin's consistently good flying throughout the day of the contest, we can discount the luck element and attribute his victory to a triumph of modeling skill. But we're the ones who are lucky—very lucky in having the plans for this outstanding model for this department. We feel they're a valuable addition to the list of championship models which have been presented in Air Trails.

DESIGN

The features which Leshner tried to include in this design are those which every championship model must have: stability, simplicity of construction and flying, and a high power-to-weight ratio. And there is another feature which he put into his model, probably too obvious for him to mention but, nevertheless, important for winning contests. It is the ability to turn in consistently good flights.

Stability is the result of ample tail surfaces (34 per cent) and comfortably long distance between the wing and tail surfaces. And, too, the 6" dihedral, which is added to each half the wing, is conducive to stable flights. Simplicity in construction is shown by the fuselage shape. It is square in cross section. Other than the cabin structure, there is no difference between the top and side views. The rudder, which is flat-sided, also, makes for easy construction. The power-to-weight ratio was kept high by using a 22-strand motor and by reducing the structural weight. A minimum of wood is used. However, it is without any decrease in strength. The method of building up the I-beam wing spar is evidence of maximum strength with minimum weight.

The model has all appearance of being a rugged outdoor model which is built not only for long flights but also to be flown day after day long after its weaker brothers have been permanently grounded. The model can be made to conform to the weight rule, regardless of what changes are made.

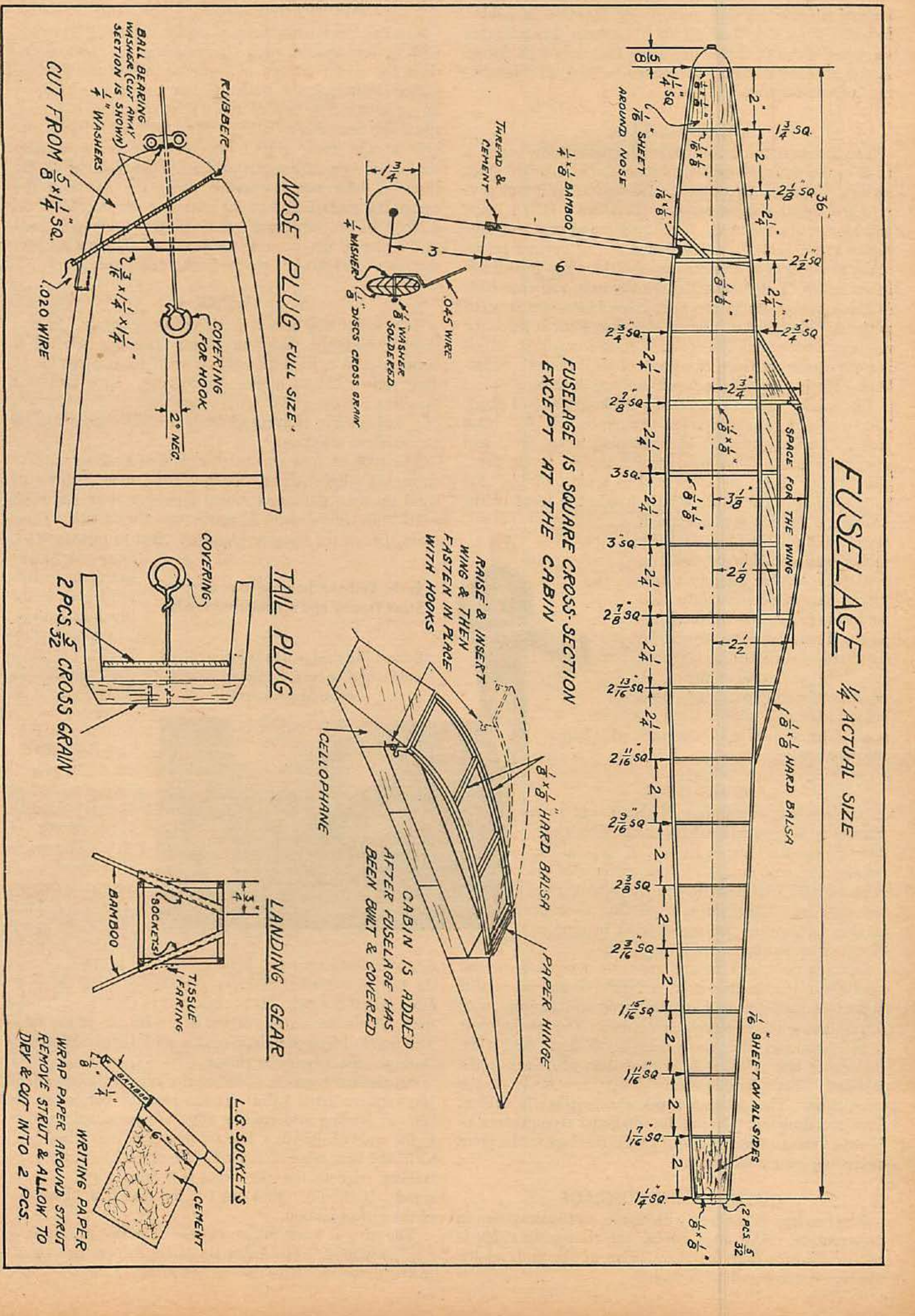
ABOUT ERVIN LESHNER

JANUARY 30, 1932, was a noteworthy date in the history of model building. On this date Ervin Leshner, who was then 13, was bitten by the model bug. He began work on his first model. He worked steadily on models for the next several years, winning a few medals and ribbons at local contests in Philadelphia. But 1936 was Ervin's big year. He started early by winning the Fuselage Event at the 1936 Eastern States Indoor Championship Meet, also getting 8th place in the Baby ROG event.

Then, for the next several months, he concentrated on outdoor flying—so effectively that he won the Stout Trophy for fuselage models at the national contest, with a flight of 36 minutes. But he didn't desert his indoor flying at this contest, as evidenced by his winning 8th place in the indoor fuselage contest. His indoor effort brought even better results later in the summer of 1936, when he set a new Class A ROG record of 11m and 50s. And then, five weeks later, he broke his own record—hanging up the present high mark of 15m and 47s.

Ervin is a skilled and enthusiastic gas modeler. He has distinguished himself in this branch of modeling as well, as with all types of rubber-powered models. But we prefer to think Ervin's real championship ability is revealed by his pleasant personality as well as his models. He works quietly and efficiently—accomplishing a thing before he'll talk about it. Winning trophies and prizes is a minor item. His real purpose seems to be to work out the problems that come up with each model. And winning the trophy is the logical outcome of his careful and methodical work.

Philadelphia is his home city. He's an active member of the N. A. A. and the Philadelphia Model Airplane Association. Their club holds more than their share of records—9 in all, including the big 3 indoor events: Class C Tractor, Fuselage, and Class A ROG.


FUSELAGE ¼ ACTUAL SIZE
36"
5/8
1 1/4" SQ
1/16" SHEET AROUND NOSE
1/8 x 1/8"
1/16 x 1/8"
2"
1 3/4 SQ.
2
2 1/8 SQ
2 1/4"
2 1/2" SQ
2 3/4" SQ
2 3/4 SQ.
2 1/4
2 7/8" SQ
3 SQ.
3" SQ
2 13/16" SQ
2 11/16" SQ
2 9/16" SQ
2 3/8 SQ
2 3/16" SQ
1 15/16" SQ
1 11/16" SQ
1 7/16" SQ.
1 1/4" SQ.
2 PCS 5/32
1/16" SHEET ON ALL SIDES
1/8 x 1/8 HARD BALSA
SPACE FOR THE WING
2 3/4"
3 1/8"
2 1/8
2 1/2"
FUSELAGE IS SQUARE CROSS-SECTION EXCEPT AT THE CABIN
THREAD & CEMENT
1/4 x 1/8 BAMBOO
1 3/4
3
6
.045 WIRE
1/8" WASHER SOLDERED
1/4 WASHER
1/8" DISCS CROSS GRAIN
RAISE & INSERT WING & THEN FASTEN IN PLACE WITH HOOKS
1/8 x 1/8" HARD BALSA
PAPER HINGE
CELLOPHANE
CABIN IS ADDED AFTER FUSELAGE HAS BEEN BUILT & COVERED
NOSE PLUG FULL SIZE
RUBBER
BALL BEARING WASHER (CUT AWAY SECTION IS SHOWN)
1/4" WASHERS
3/16 x 1/4 x 1/4"
COVERING FOR HOOK
2° NEG.
CUT FROM 5/8 x 1 1/4" SQ.
.020 WIRE
TAIL PLUG
COVERING
2 PCS 5/32 CROSS GRAIN
LANDING GEAR
3/4"
SOCKETS
BAMBOO
TISSUE FARING
L.G. SOCKETS
1/8"
1/4"
BAMBOO
6
CEMENT
WRITING PAPER
WRAP PAPER AROUND STRUT REMOVE STRUT & ALLOW TO DRY & CUT INTO 2 PCS.

Its rugged construction permits an increase in rubber motor without any "beefing up." Leshner demonstrated the possibilities of this ship during last summer's flying. And it should make an ideal design to start off this summer's contest flying.

CONSTRUCTION

The fuselage is of conventional construction—even a trifle easier than the average, because of the square cross section. The main part of the fuselage is built and covered and then the cabin structure is added. ⅛" sq., hard balsa longerons are used. The upright and cross fuselage braces are 1/16x⅛" put in edgewise. At several points along the fuselage, indicated in the drawing, the size is increased to ⅛x⅛" balsa. Both the nose and rear ends of the fuselage, up to the first cross brace, are covered with 1/16" sheet balsa. Since no motor stick is used, the fuselage must stand considerable rough handling, which is concentrated at these two parts of the fuselage. Sheet-balsa covering makes the fuselage more durable.

The fuselage should be fitted with nose and tail plugs. The rear plug is made from two pieces of 5/32" balsa cemented cross-grain. The front plug is cut from two pieces of balsa. The semicircular nosing is cut from ⅝x1¼x1¼" balsa and cemented to a piece of 3/16" flat balsa, which is cut to fit snugly inside the front of the fuselage. Notice the notch which is cut in the nose plug, and the rubber-band attachment which is used to hold this plug in place. ¼" washers are cemented to both the inside and outside of the front plug. These washers should be cemented so the shaft is staggered at a 2-degree negative angle. A small ball-bearing washer is used between the nose plug and the propeller. A good bearing surface is necessary with large rubber motors.

Ervin Leshner holding the coveted Stout Trophy and the winning model.

LANDING GEAR

Single struts of bamboo ⅛x¼x9" cut to a streamline shape are used for the landing gear. The wheels are extended about 3" beyond the ends of the bamboo strut. They are carried on axles of .035 wire bent to the shape shown in the drawing. The purpose of this peculiar bend is to prevent the wheel from turning in or out when landing.

Landing-gear sockets are made by wrapping several thicknesses of cement-coated writing (or any other stiff paper) around the end of the strut and binding with thread plus a liberal coating of cement. The landing-gear strut is removed while the cement is still dry. And when the socket has dried, it is cemented in place inside the fuselage. Both landing-gear sockets are made at the same time. The position inside the fuselage is evident from the drawing. Notice the diagonal strengthener of 1/16x⅛" balsa, which is added to the fuselage at the point of landing-gear attachment.

COVERING THE FUSELAGE

The fuselage is covered with tissue, as the next step in construction. And after doping the tissue, the cabin is added. Notice that the sheet balsa at the ends of the fuselage are covered with tissue.

ADDING THE CABIN STRUCTURE

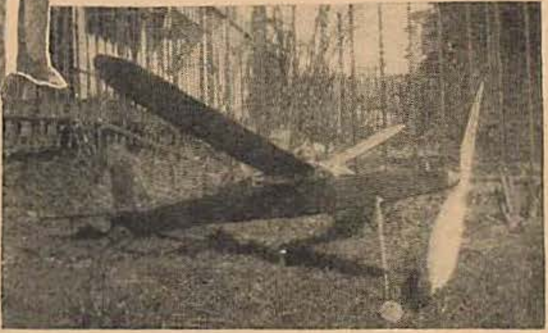
The cabin is intended as a place for mounting the wing, with a view toward good streamlining, and, also, to inclose the center section of the wing inside the fuselage and avoid having the center section counted as effective lifting area. The top of this cabin structure is hinged about the rear and is held in place with wire hooks and eyes at the front edge. ⅛x⅛" hard balsa is used throughout the cabin structure. When joining to the fuselage, take care to scrape away the tissue at the cementing surface and make certain to cement the wood directly to the longeron. A tissue-paper hinge is used at the rear of the movable top portion. The entire front portion of the cabin is covered with cellophane.

WING

The Eiffel 400 airfoil is used in the wing. It is a popular section among modelers. Leshner selected it because it is a high-lift section with its highest lift to drag ratio (22) at minus .75 degrees. This airfoil is excellent for the glide. And since most of the duration of a model's life is spent gliding, the Eiffel seems to be an excellent selection.

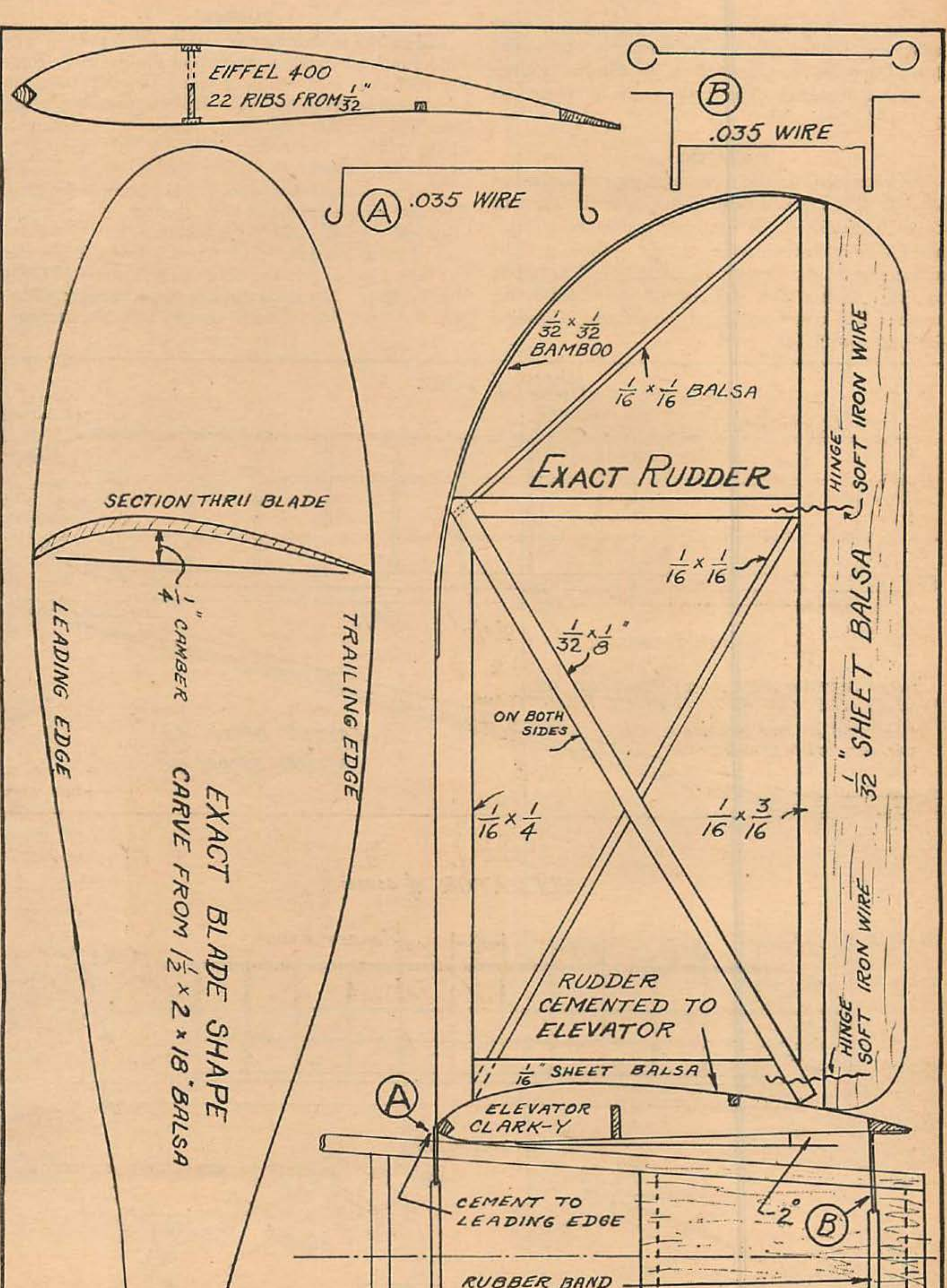
The type of spar construction which Leshner used is strong and lightweight. It is a trifle more tedious to build up than the conventional type, but it seems to be worthwhile investment to work out the details. The main spar of the wing is 1/32x½". But to reënforce the spar against bending, strips are added to the top and bottom. The spar is practically the same depth as the rib. Therefore, it is necessary to cut a notch in both the rib and the spar, forming a "lap joint." The spar is notched to a depth of ¼". The rib is notched just slightly deeper. The final joint should be made so that there is a 1/32" space remaining between the top of the spar and the top of the rib. A piece of balsa 1/32x⅛" balsa is fitted into this notch. It is cemented to the rib and to the spar. A similar strip is added to the bottom of the spar. The finished spar should resemble an I-beam. A section through this I-beam is shown.

Below: The design, featuring a raised cabin and square fuselage, is original and practical.



An auxiliary spar is added to the rear of the rib. It is 1/16" square, hard balsa. It fits into the bottom of the rib. A leading and trailing edge are cemented in place to the ends of the rib. The trailing edge is notched 1/16" to fit the rear edge of the rib. Be careful to cement the trailing edge to the ribs so it is turned slightly downward. It should round out the top and bottom camber of the airfoil section.

The wing is made in two pieces. The tips are bamboo, 1/16", rounded. The balsa tip strengtheners are shown in the drawing. The two halves of the wing are joined


EIFFEL 400
22 RIBS FROM 1/32"
B
.035 WIRE
A
.035 WIRE
1/32 × 1/32 BAMBOO
1/16 × 1/16 BALSA
EXACT RUDDER
HINGE
SOFT IRON WIRE
SECTION THRU BLADE
1/4" CAMBER
LEADING EDGE
TRAILING EDGE
EXACT BLADE SHAPE
CARVE FROM 1½ × 2 × 18" BALSA
1/16 × 1/16
1/32" SHEET BALSA
1/32 × 1/8"
ON BOTH SIDES
1/16 × 1/4
1/16 × 3/16
HINGE
SOFT IRON WIRE
RUDDER CEMENTED TO ELEVATOR
1/16" SHEET BALSA
A
ELEVATOR CLARK-Y
CEMENT TO LEADING EDGE
2°
B
RUBBER BAND

by a center section which consists of 3" lengths of spar, leading and trailing edges. No extra ribs are needed when joining the two wing halves. 6" dihedral is given to each half the wing. The center section is covered on top with 1/32" sheet balsa.

ELEVATOR

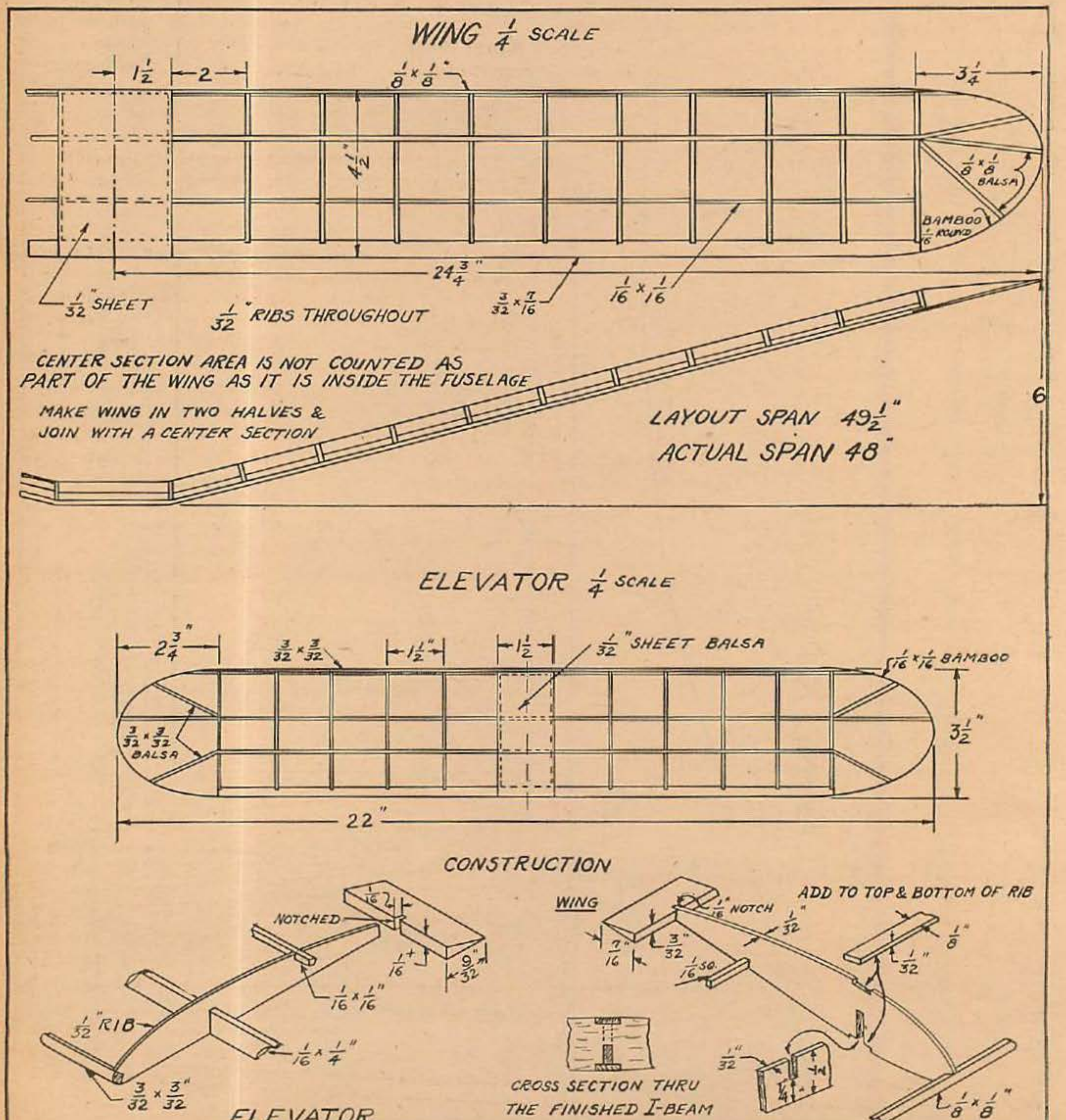
This construction follows the same general method as the wing. The Clark-Y airfoil section is used. The type of spar is simplified. It is merely a piece of 1/16x1/4" balsa fitted into notches which are cut in the ribs. The trailing edge of the elevator is notched 1/16" to receive the ribs. Bamboo tips of 1/16x1/16" are added to the elevator. The center section of the elevator is covered with 1/32" sheet balsa.

RUDDER

The rudder is shown exact size in the drawing. The rudder is fixed rigidly to the top of the elevator. Rudder control is obtained by a small, movable balsa tab which is attached to the rear. It is cut from 1/32" sheet balsa and soft iron-wire hinges join it to the main part of the rudder. The rudder is flat—no ribs being used in the construction.

The elevator and rudder are attached by two wire clips. The rear clip is cemented to the bottom of the trailing edge and the front one to the leading edge. The exact size of these attaching clips are indicated. Their size has been fixed to give the elevator two degrees of negative incidence. If your fuselage has been accurately built you can check this incidence directly from the drawing.

(Turn to page 92)



The Discussion CORNER

The model art progresses through exchange of ideas. The Discussion Corner is a monthly sounding board for your opinions. This month readers discuss adjustable-pitch propellers. *For June the subject is* gas model construction handicaps. *Other topics are listed below. Think about them, then write your opinion in 150 words or less and send it to The Discussion Corner. One dollar is paid for each answer printed.*

ADJUSTABLE-PITCH propellers would be very advantageous for outdoor contest models. The pitch at the beginning of the flight should be fairly high (1.7 or 1.8 pitch-diameter ratio). As the power diminishes the pitch should decrease to 1.3 P/D ratio. And when the power is completely exhausted the blades should feather and assume the angle of least resistance for the glide.

This arrangement will give almost constant thrust and will lengthen the propeller run by flattening and extending the power curve. A propeller of this type should be about 15 per cent more efficient and will make the model easier to adjust and more stable, by eliminating stalling possibilities at the beginning of the flight and providing a constant, steady climb to the last turn. The mechanical device necessary for such a propeller can be very light and simple with positive action.—Edward Lidgard, Chicago, Ill.

This Month's Topic

Would adjustable-pitch propellers be of advantage in outdoor models? If so, how should the pitch vary?

I think an adjustable-pitch propeller would be of little advantage on an outdoor model, for the following reasons:

1. An efficient adjustable-pitch propeller would necessarily mean an increase in weight; this is undesirable.
2. At the flying field the blades might get out of pitch and valuable time would be lost in getting the correct pitch on the blades.

Although these are only two of many reasons, they are enough to dissuade me from making adjustable-pitch propellers.—Paul Crieb, Springfield, O.

Adjustable-pitch propellers for outdoor models would be of advantage in calm flying weather. The pitch should vary as: at the start of the flight the pitch decreases, which makes the model grab for altitude in a great hurry; then, as the power dies down, the pitch slowly changes back to normal, or to what is a cruising pitch. Here in the Middle West we had some success with indoor models using the adjustable-pitch propellers, and I believe the same principle could be used on outdoor models (but for only calm weather; results would be much different in rough type of weather).—Walter C. Kutaj, Chicago, Ill.

If the mechanism can be perfected, I believe that automatic, adjustable-pitch propellers would be of immense value to outdoor models. The propeller should be adjusted to a low pitch, to give the model a good, fast, and efficient climb. As soon as it reaches its maximum altitude the propeller should automatically adjust itself to a higher pitch, to give the model a long cruise and maximum glide. When the blades are adjusted to a high pitch there is less frontal area and a good glide is assured. This high pitch and the freewheeling give the model more of a chance to "catch" a rising thermal.—Sidney Bernstein, Far Rockaway, L. I.

I do not believe adjustable propellers are necessary on model planes. The main use of adjustable-pitch propellers on large planes is to maintain maximum efficiency at different inclinations and speeds of flight, a low pitch being used for take-off and a higher for cruising.

Models do not vary their speed enough to really need a change in pitch. In order to install any type of adjusting device the free-wheeling device of contest models would be interfered with. Besides, it makes the hub too heavy and bulky.

As far as changing a model from a slow-flying ship to a fast one is concerned, merely changing the pitch of the propeller will not be enough. A change of incidence and even the wing span often is necessary.

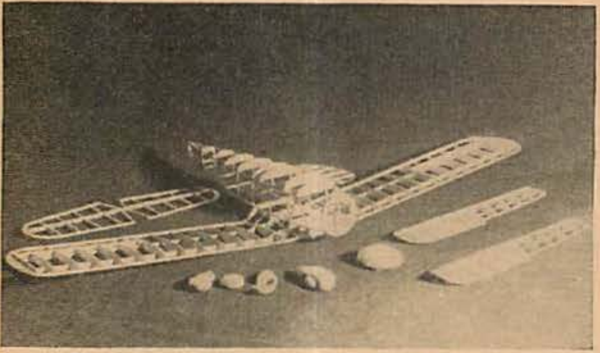
In conclusion, I will say that if adjustable propellers were to be used, there would be always the problem of lining up both blades with equal pitch.—Bob Piefer, Chicago, Ill.

An adjustable-pitch propeller hinders rather than helps the duration of an outdoor model. An adjustable-pitch propeller to be helpful, even theoretically, must decrease its pitch as the motor unwinds and the torque decreases. The high-propeller pitch at the beginning *(Turn to page 96)*

COMING UP are these topics:

For July—*Which type do you prefer for best results in the original flying model: parasol, wing flush with fuselage top, or low wing?* Answers must reach us by April 15th.

For August—*Do you believe that gas-model construction will either wholly or partially displace the long-popular rubber-driven model? Which of the two types is your preference?* Answers must reach us by May 15th.



The uncovered framework shows the ruggedness and simplicity of the structure.

With Wheels Or Pontoons

A Flying Scale Model of the Arrow Sport Plane

by Alan D. Booton

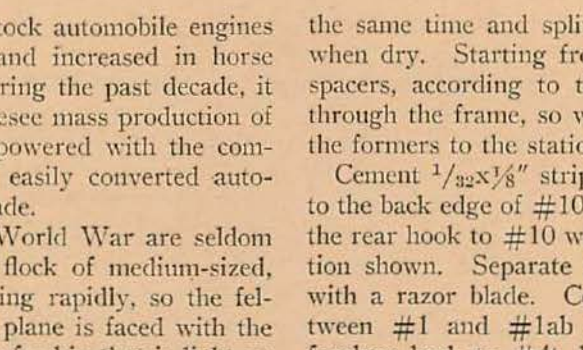
FOR the simple reason that stock automobile engines have decreased in weight and increased in horse power and dependability during the past decade, it takes but little imagination to foresee mass production of safe, low-priced plane designs—powered with the coming lighter and higher-powered, easily converted automobile engines—in the next decade.

The surplus planes from the World War are seldom seen outside museums, and the flock of medium-sized, second-hand planes are diminishing rapidly, so the fellow who is eager to fly his own plane is faced with the problem of finding a reasonably safe ship that is light on the purse for initial cost and upkeep thereafter. It used to be possible to build and fly your own plane, but now most States require all ships to be licensed, so that heads the prospective pilot in another direction.

Years ago, Henry Ford became interested in lightplane possibilities, but immediately abandoned the idea when his first venture ended fatally for his young pilot.

During the past two years, several pioneering companies have attempted to place on the market, with little success, planes powered with auto engines. The use of Ford engines seems to predominate. This month, Air Trails presents the Arrow Model F. The Arrow, powered with a converted Ford V-8 engine rated at 82 h.p. at 3,075 r.p.m., climbs 500 ft. per min., does 90 m.p.h. full out, cruises at 85 m.p.h., and lands at 45 m.p.h. with flaps down or 48 m.p.h. without flaps. The model is of conventional design and is very easy to build. After the model was tested and the stolid stability noted, the author decided to include the scientific float design for the readers' benefit.

The Arrow Model F



The landing gear can be quickly changed to floats for hydro work.

When equipped with pontoons, the graceful lines are enhanced. The rear-quarter view reveals the instrument panel and other details.

FUSELAGE

Place waxed paper on the drawing to prevent sticking. A bread or drawing board makes an ideal surface to work on. Build two sides of the fuselage frame of $^1/_{16}$" sq. at the same time and split them apart with a razor blade when dry. Starting from the rear, cement in the $^1/_{16}$" spacers, according to the top view, and keep sighting through the frame, so warps can be prevented. Cement the formers to the stations indicated.

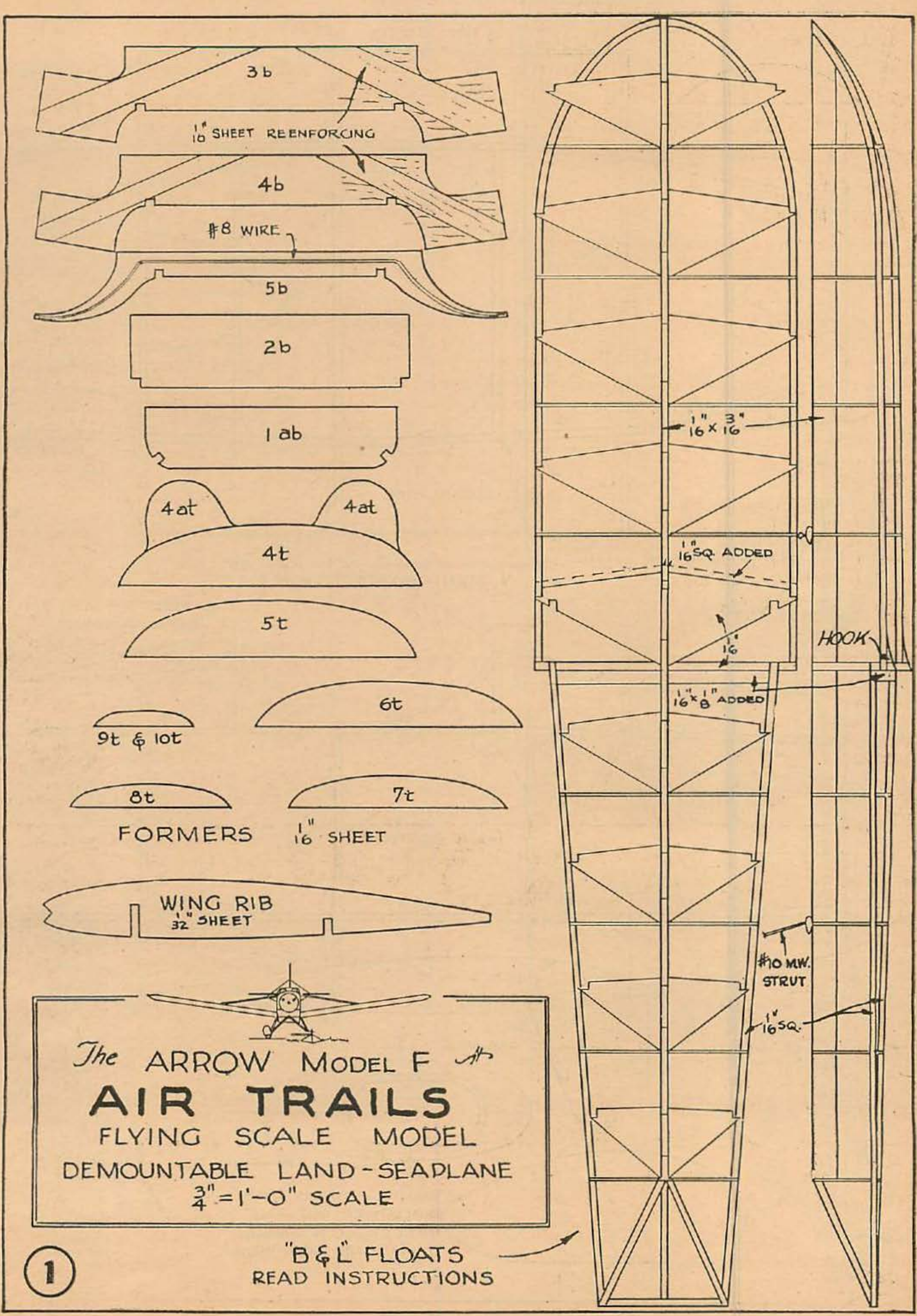
Cement $^1/_{32}$x⅛" strips to the inside of #9 to extend to the back edge of #10, to form the plug effect. Cement the rear hook to #10 with a piece of ⅛" sq., in the position shown. Separate the rear portion of the fuselage with a razor blade. Cover the fuselage completely between #1 and #1ab and #2t, then the top of the fuselage back to #4t, leaving the cockpit, then the top of the removable rear end, with $^1/_{32}$" sheet balsa.

Carve the nose block and cement the $^1/_{16}$x⅛" strips on as shown on the nose block detail. Insert a double bearing (if you prefer) in the nose block. The bearing is made of one length of $^3/_{32}$" alum. tube to turn freely. Knurl the ends of the $^3/_{32}$" tube to hold the $^1/_{16}$" tube in. Bend the double-acting landing parts and cement them to the fuselage. Note that the #14 music wire extends from axle to axle and the #10 music wire is only bent over the #14 music wire. As the #14 music wire part is bent, be sure to include the $^1/_{16}$" tube bearing.

This bearing is heavily cemented to the rear-bottom edge of #3b. A length of ⅛" flat rubber forms the inner struts and is installed with considerable tension. Attach the tail wheel with a #8 wire fitting shown in detail. An easy way to install the wheels in the pants so they may be attached to the axles without "fiddling" many minutes, is to cement $^3/_{32}$" alum. tube bearings in the wheels and then mount the wheels in the pants on $^1/_{16}$" alum. tube. The pant-wheel unit can then be quickly placed on the axle.

WINGS AND TAIL SURFACES

Assemble the wing panels on your work board, using plenty of pins to keep the many parts lined up. *(Turn to page 93)*



The ARROW Model F

AIR TRAILS

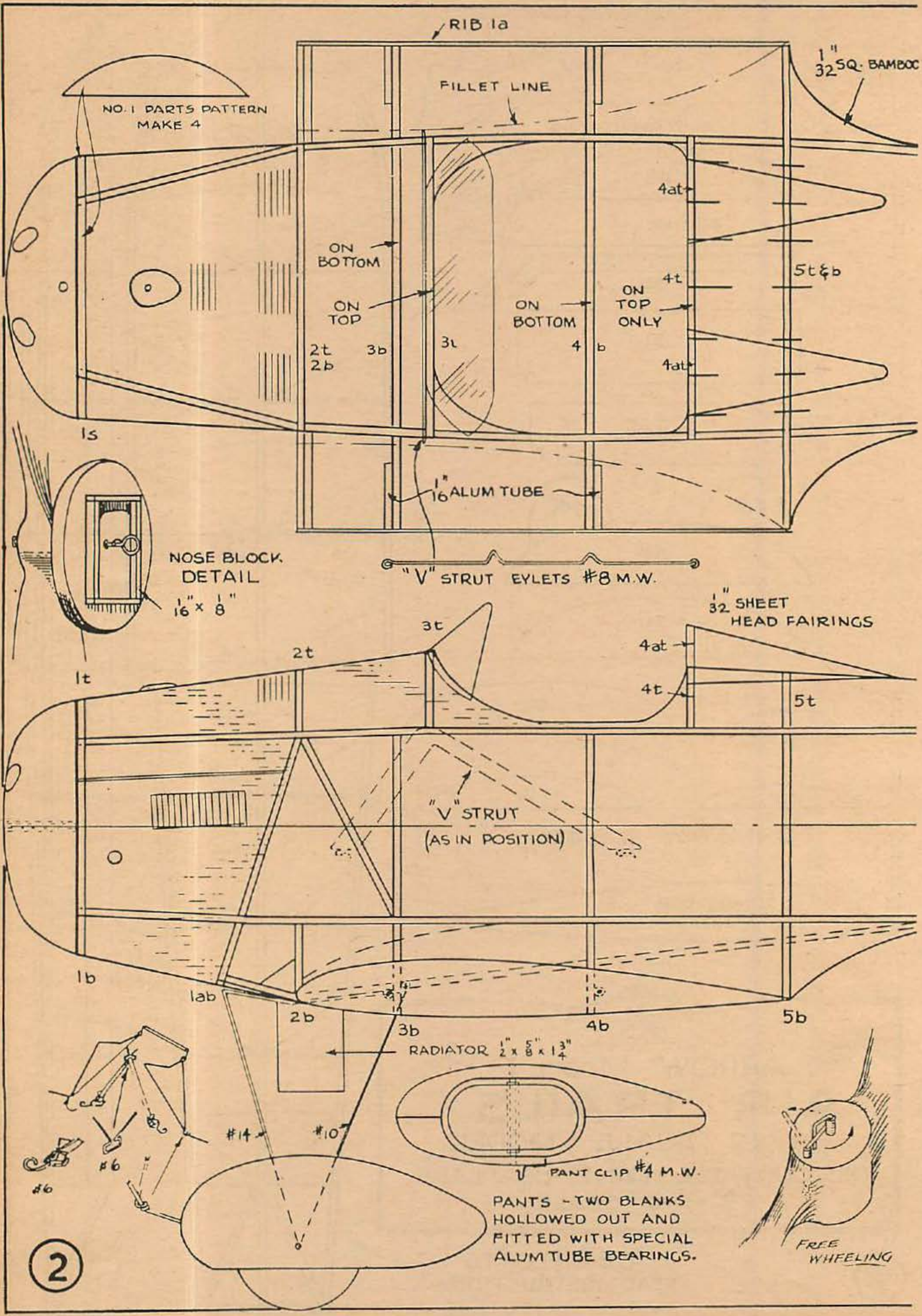
FLYING SCALE MODEL

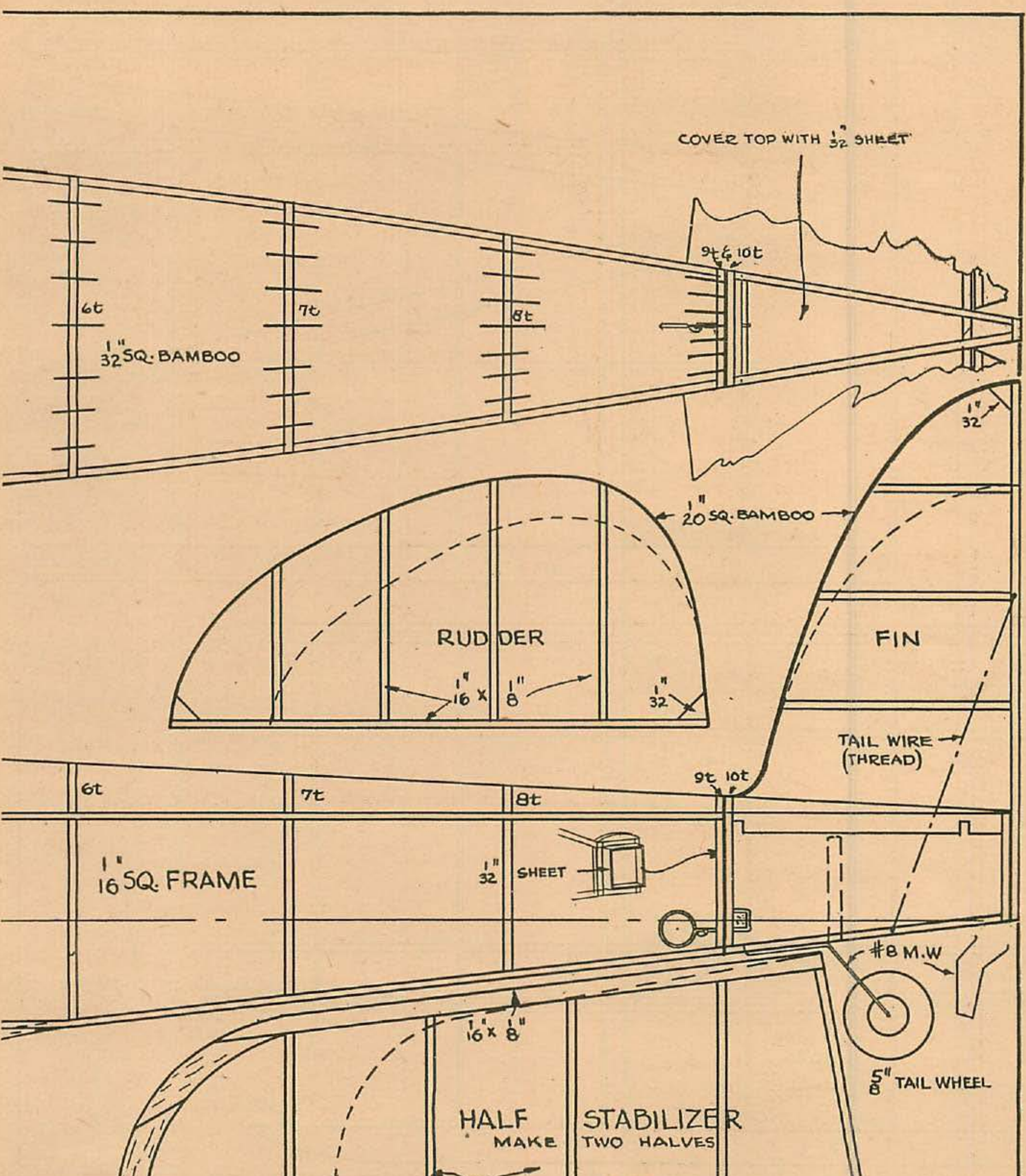
DEMOUNTABLE LAND-SEAPLANE

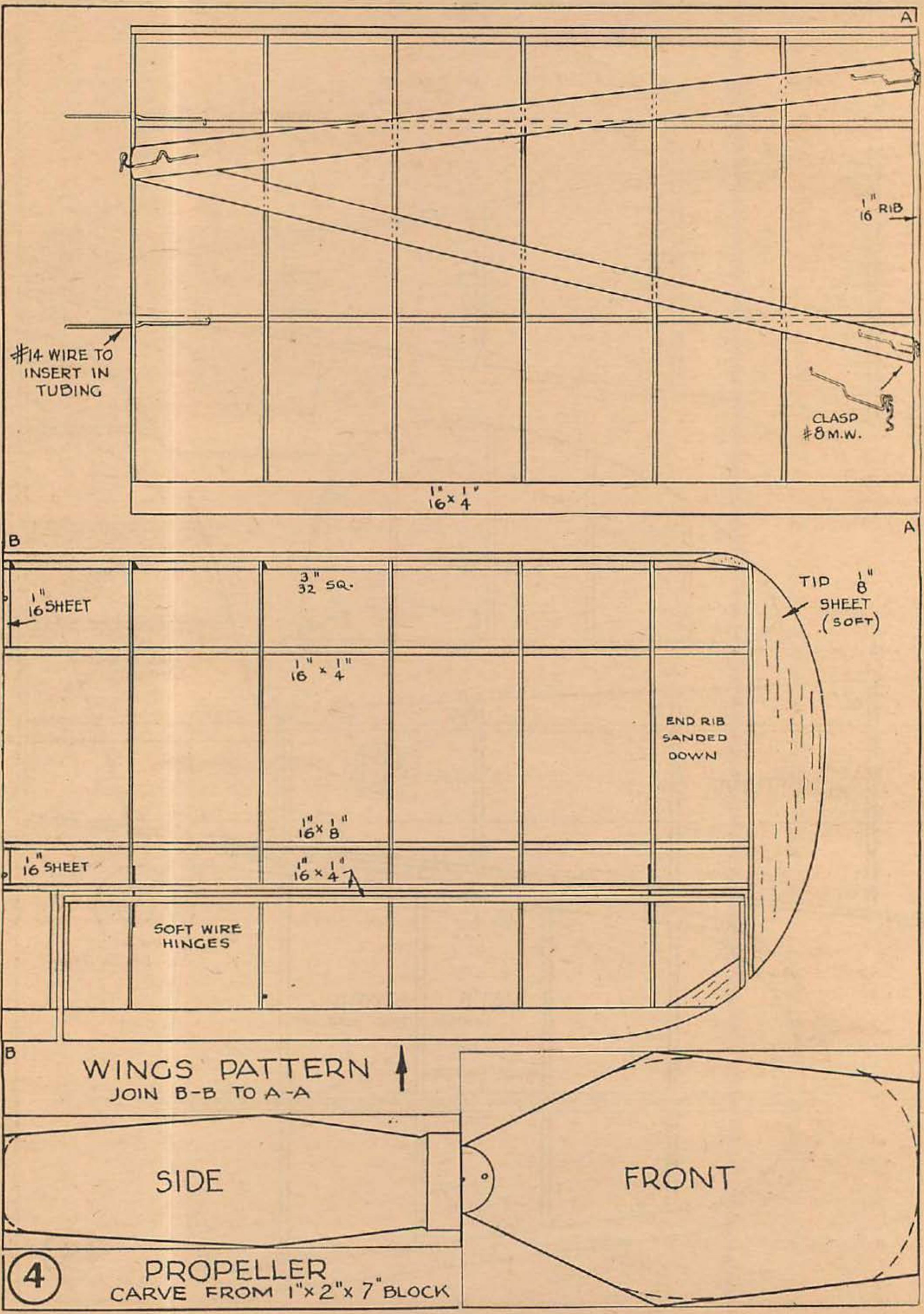
$\frac{3}{4}$" = 1'-0" SCALE

"B & L" FLOATS
READ INSTRUCTIONS

①


RIB 1a
1/32" SQ. BAMBOO
FILLET LINE
NO. 1 PARTS PATTERN MAKE 4
4at
ON BOTTOM
5t & b
4t
ON TOP
ON BOTTOM
ON TOP ONLY
2t
2b
3b
3t
4
b
4at
1s
1/16" ALUM TUBE
NOSE BLOCK DETAIL
1/16" × 1/8"
"V" STRUT EYLETS #8 M.W.
1/32 SHEET HEAD FAIRINGS
3t
4at
2t
1t
4t
5t
"V" STRUT (AS IN POSITION)
1b
1ab
2b
3b
4b
5b
RADIATOR 1/2" x 5/8" x 1 3/4"
#14
#10
#6
#6
PANT CLIP #4 M.W.
PANTS - TWO BLANKS HOLLOWED OUT AND FITTED WITH SPECIAL ALUM TUBE BEARINGS.
FREE WHEELING
2


COVER TOP WITH 1/32" SHEET
9t & 10t
6t
7t
8t
1/32" SQ. BAMBOO
1/32"
1/20" SQ. BAMBOO
RUDDER
1/16" x 1/8"
1/32"
FIN
TAIL WIRE (THREAD)
9t 10t
6t
7t
8t
1/16" SQ. FRAME
1/32" SHEET
#8 M.W
1/16" x 1/8"
5/8" TAIL WHEEL
HALF STABILIZER
MAKE TWO HALVES
RIBS & SPARS 1/16" x 1/8"
1/16" x 3/16"
3



WINGS PATTERN

JOIN B-B TO A-A

PROPELLER

CARVE FROM 1"x 2"x 7" BLOCK

Have you a question on model building or flying that bothers you? Bring us your problem and ? *we'll answer it in the interest of readers everywhere. Replies by mail require return postage.*

LIGHT WOODS FOR MODELS

Question: What is the lightest weight wood, other than balsa, suitable for gas-model construction? J. M., Chicago, Ill.

Answer: Pine and spruce are both about three times the weight of balsa wood—and they are the lightest woods other than balsa which can be used in gas models. Pine and spruce are cheaper than balsa and can be obtained at any lumberyard. Despite the increased weight, these woods can be used efficiently in gas models. Their greater strength permits the use of smaller sizes. While the gas model built of pine and spruce would not be as light as one of balsa, the slight increase in weight would not offer any serious handicap, as it would to a small rubber-powered model built from pine or spruce.

NEGATIVE THRUST

Question: What is meant by negative thrust and what effect does it have on the flight of the model? G. M., Manette, Wash.

Answer: Negative thrust is offsetting the propeller shaft so it points slightly downward instead of pulling straight forward. The plans for Ervin Leshner's Stout winner in this issue show the propeller set at 2 degrees negative thrust. With the propeller pulling downward the model shows less tendency to stall, especially when under full power. Negative thrust improves the glide. As long as the propeller is turning, the negative thrust keeps the nose of the model low, but in the glide this downward force is no longer present and the model naturally follows a flatter glide path.

Many of the present contest modelers use right thrust as well as negative thrust. Right thrust helps the model maintain a steady turn under power, by having the propeller counterbalance the natural tendency of the torque to turn it to the left. Thus a steady turn to the right can be obtained without excessive warping of the wing or the rudder. And since the torque is no longer present in the glide, the model will still maintain a uniform right circle.

SCALE MODEL FLOATS

Question: Could you tell me what size floats I should use on a Beechcraft B17L model with a span of 24 inches? D. C., Toronto, Ont.

Answer: The type of floats will be determined by whether or not you want to fly this model off the water or merely want the floats to complete a scale model. A pair of floats suitable for this model, scaled down from the size that would be used on the full-size Beechcraft, would have the following dimensions: length 15½ inches, width 2¼ inches, height 1⅝ inches, and the distance between the floats would be 7 inches. The floats should have V-shaped bottoms with rounded tops. You can get a good idea about float shapes by referring to the photos of twin-float seaplanes which appear frequently. All floats follow the same general proportions, the only big difference is in the size—regulated by the weight of the airplane for which they are intended.

Floats suitable for an actual off-the-water flight with a model are too difficult to describe here. We'd suggest you use a scaled-down version of the type that was presented in the November issue of Air Trails (1936). This particular article was titled: *Fun Afloat.*

GAS-MODEL TIMERS

Question: Where can I obtain a camera timer like the one used in the Sky King gas model (Feb. and Mar. issues of Air Trails)? K. A., Camden, N. J.

Answer: The timer is available in two sizes, costing $1.25 and $1.50. The smaller size has a capacity for timing up to 45 seconds and the larger size up to 70 seconds. The particular type of timer used in this model was the Haka Autoknips and was purchased at a camera supply store. We suggest you try the store near your home. Be sure to specify this particular type—or at least make sure that you get one similar to it. There are a wide variety of other camera timers available which give split-second accuracy but run for only a few seconds and, in addition, are too expensive for use in models.

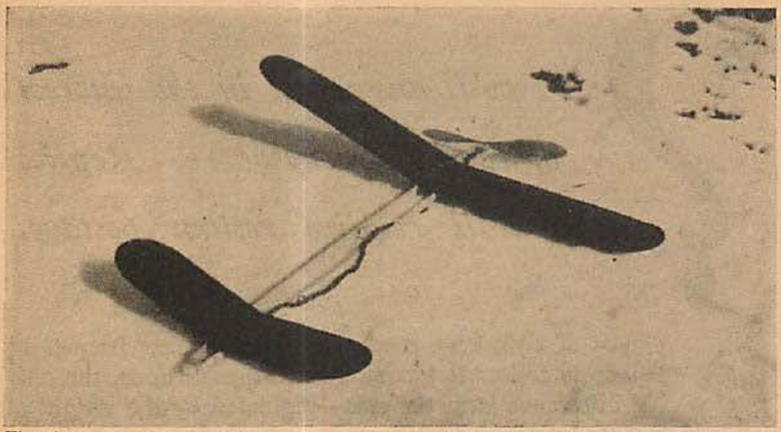
The Autoknips is used in photography for self-portraits. It is set to "click" the camera after a short time, giving you a chance to get in front of the camera and pose for the picture.

SCALE GAS MODELS

Question: Is it possible to make a gas model from scaled-down plans of full-size airplanes? J. D., Manchester, Mass.

Answer: Scale models of large airplanes make excellent gas models. Not only can the conventional type of airplane design be used, but unusual types such as the Waterman Arrowplane and other tailless varieties. Pusher airplanes, such as the Stearman-Hammond or the Fairchild amphibian, with the motor mounted atop the wing, could be reproduced as gas models with very pleasing results.

Practically every type of airplane has been built as a gas model. This is done by merely scaling down the proportions of the real ship and making a few necessary structural changes. The builders on the Pacific coast are especially interested in scale gas models. And from the photos of their ships they've developed it to perfection. The results of their contests prove that they fly well. The most ambitious project along these lines that we've ever heard of is a model of the Douglas Sleeper which is being built. Two gas motors turning in opposite directions will power this model. An attractive model of the Douglas, plus the thrill of a bimotored gas job, should be a worthwhile development in modeling.



The bow-framed pusher is a pleasant change for the active modeler.

The INSUROR

A Beginner's Model which insures a novice of success.

A BEGINNER'S FAITH in modeling is usually strained when his new model refuses to fly. Enthusiasm about his new hobby drops with each unsuccessful attempt to fly it. It takes a good flight to fully restore his confidence. Unfortunately, new models are usually rather slow to show results when handled by beginners, and a simple, easy-to-fly model should always be kept in flying trim for just such occasions.

So, we suggest that you build this pusher model as a sort of insurance against the time when you'll be discouraged by bad results. It will be a tonic for low spirits.

The single pusher is the ideal model to provide such insurance. The cost is small and you'll get paid full value when it is necessary to cash in your policy. The single pusher offers the best in flying for the least in building.

I've seen crude pusher models built by the most inexperienced beginner turn in some exceptional flights. Our model club used to specialize in holding contests for single pushers. We allowed the entrants a wide flexibility in rules—single or double-surface wings with unrestricted range of sizes. Practically all the beginners were able to turn in flights of 50 to 60 seconds. And many of these flights were hand-wound. When the weather was good it was not unusual to lose several models with fly-away flights.

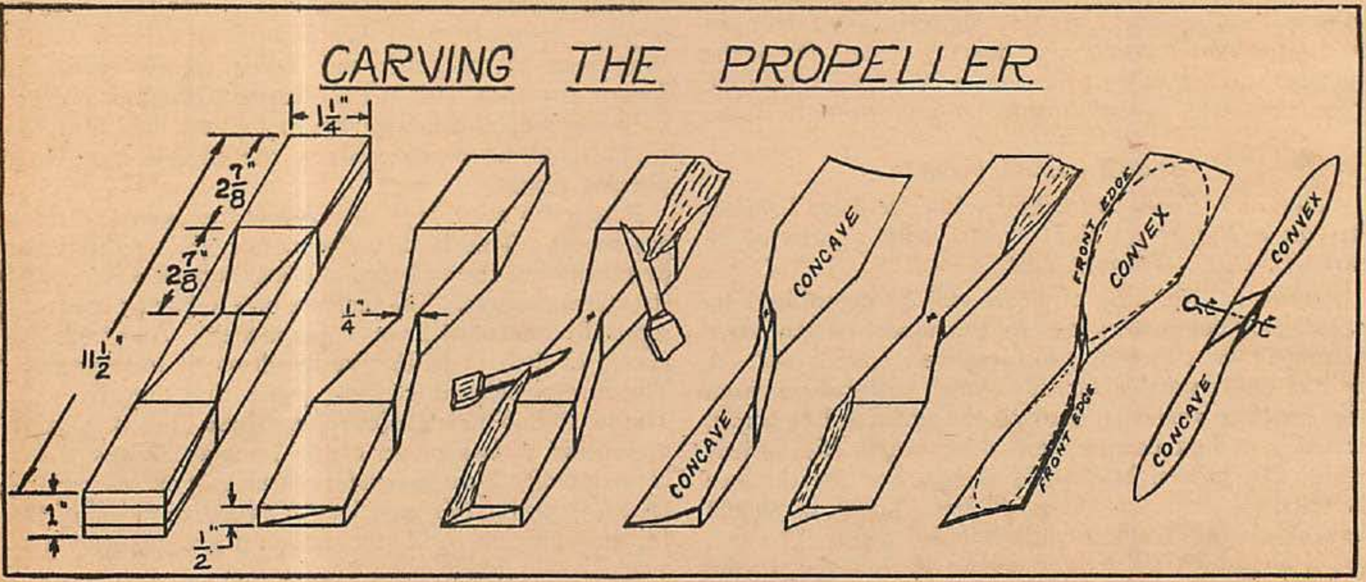
The simplicity of the single pusher kept interest among club members running high. Even after the beginners were qualified to tackle a more difficult type of model they continued to spend part of their time building and flying single pushers. An afternoon of pusher flying gave them much valuable experience and enough enthusiasm to carry them over the rough spots in their modeling careers.

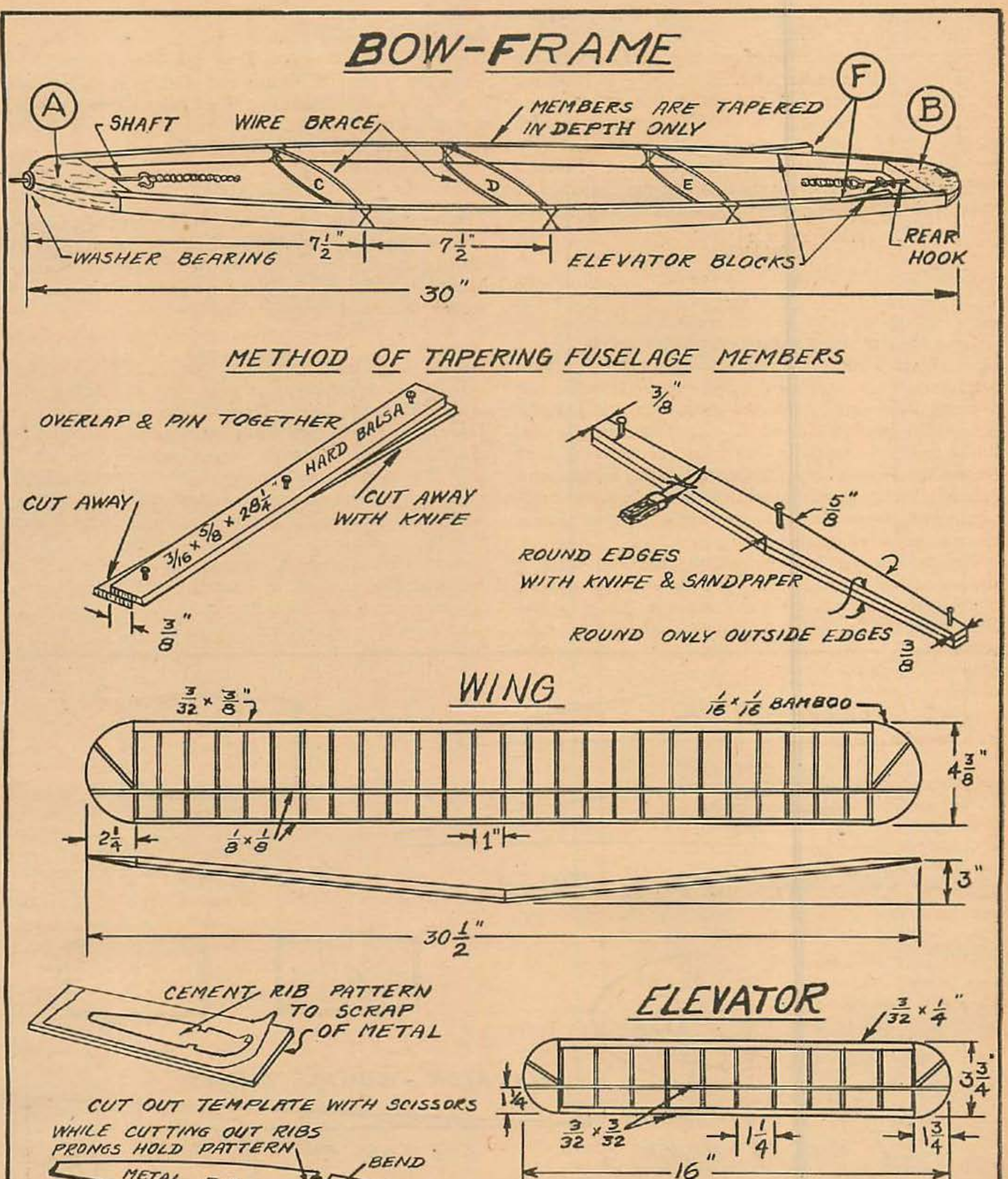
So take time out from your more difficult models and build up your enthusiasm with a few single-pusher flights.

BOW FRAME

The frame is built from two pieces of 3/16x5/8x28½" balsa. The two pieces are joined at the ends and separated in the center by wire strengtheners. This peculiar shape of the frame accounts for the descriptive title. The two fuselage members are tapered from 5/8" at the center to 3/8" at the ends. The simplest method of doing this is shown in the drawing. Pin the two pieces together so the ends overlap 3/8". Then cut away the excess wood—using the edge of the one piece as a guide when cutting the second piece. The outside edges of the two pieces are rounded with knife and sandpaper while the pieces are still pinned together.

Next cut the front and rear parts of the frame from 3/8" balsa. These are labeled A and B in the drawing of full-size parts. The frame members fit into these pieces—securing them with cement and thread. The two frame members are held apart by three wire strengtheners. These are bent from heavy wire (C, D, and E). These




BOW-FRAME
A
SHAFT
WIRE BRACE
MEMBERS ARE TAPERED IN DEPTH ONLY
F
B
C
D
E
WASHER BEARING
7½"
7½"
ELEVATOR BLOCKS
REAR HOOK
30"
METHOD OF TAPERING FUSELAGE MEMBERS
OVERLAP & PIN TOGETHER
3/16 × 5/8 × 28¼" HARD BALSA
CUT AWAY
CUT AWAY WITH KNIFE
3/8"
3/8"
5/8"
ROUND EDGES WITH KNIFE & SANDPAPER
ROUND ONLY OUTSIDE EDGES
3/8
WING
3/32 × 3/8"
1/16 × 1/16 BAMBOO
4⅜"
2¼
1/8 × 1/8
1"
3"
30½"
CEMENT RIB PATTERN TO SCRAP OF METAL
CUT OUT TEMPLATE WITH SCISSORS
WHILE CUTTING OUT RIBS PRONGS HOLD PATTERN
BEND
METAL RIB SHAPE
NOTCH FOR SPAR
3/32"
SAND RIBS
3/32 × 3/32"
PIN RIBS TOGETHER
3/32 × 3/32"
ELEVATOR
3/32 × 1/4"
3¾"
1¼
3/32 × 3/32
1¼
1¾
16"
2"
ELEVATOR ATTACHING
3½"
ELEVATOR
FRAME
RUBBER BAND
INCIDENCE BLOCK "F"

wire strengtheners are cemented and threaded to the inside of the frame members.

The next step in the frame construction is to bend the propeller shaft and rear hook. The shape of these are identical. The rear hook is inserted through the balsa piece (B) and cemented. The shaft is inserted through piece (A). A washer is cemented to the front of (A) which serves as a bearing for the propeller. Elevator incidence blocks (F), shown full-size, are cemented to the top of the frame members $3\frac{1}{2}''$ from the front.

WING

Cutting ribs is at best a tedious process—and making them accurately, as they should be, makes the process even more tedious. The easiest way we know to cut ribs is by using a metal template. This can be cut from a piece of scrap metal. A time-saving trick in using a metal template is to bend the edges of the template into a prong which will fit into the sheet balsa and hold the template firm while the rib is cut. With the rib used in this model the set-up is ideal. Instead of cutting away the metal to provide a notch for the top and bottom spar, merely bend the excess metal to form a prong. In addition to speeding up rib cutting these prongs will insure a uniform size of notch for the spars.

Pin the ribs together after cutting and sand them to the same shape. And at this time make sure that the ribs are $^{3}/_{32}''$ at the rear ends and notched $\frac{1}{8}$x$\frac{1}{8}''$ at the front edge.

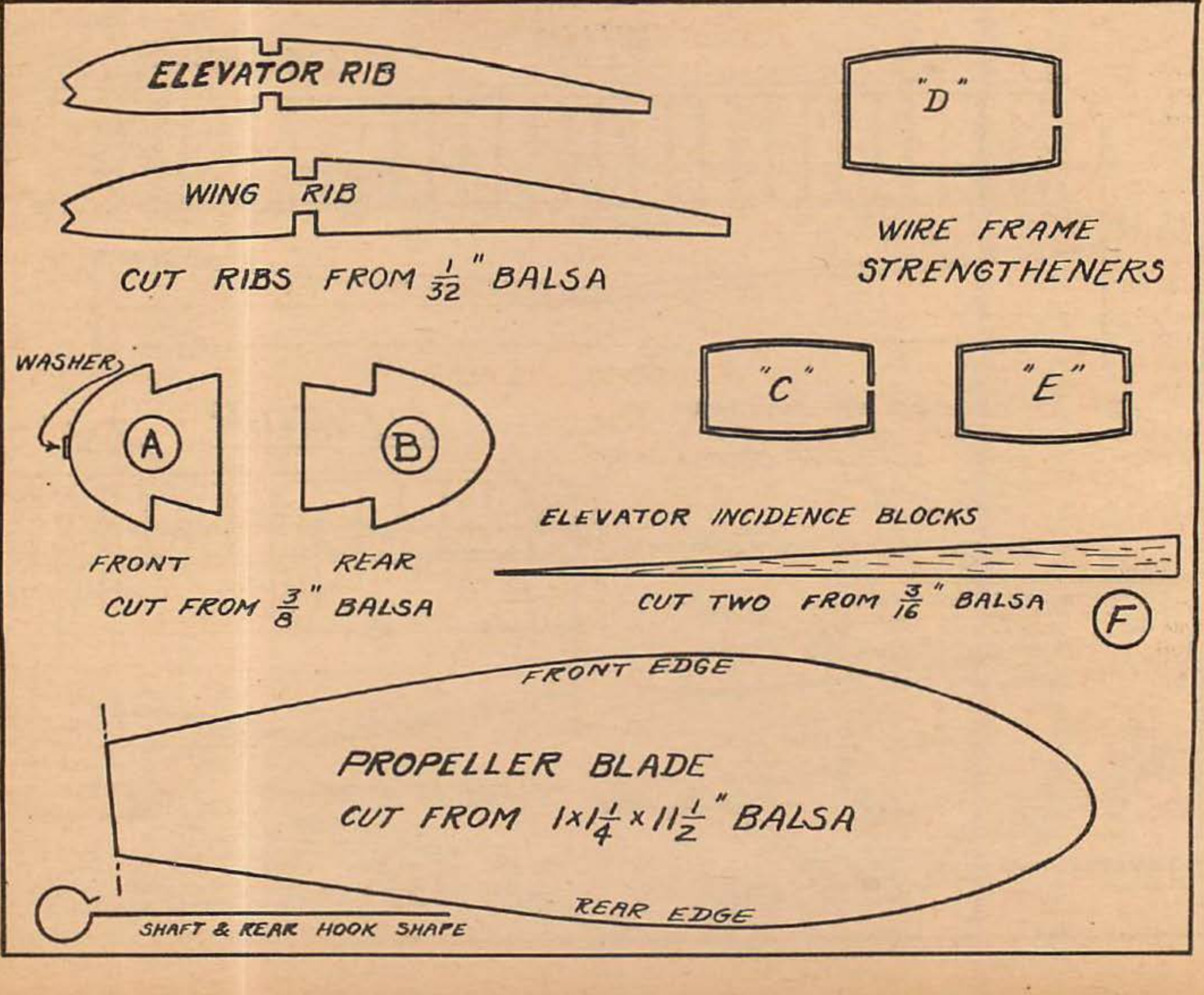
The wing is assembled in one piece. You'll probably find a simple, full-sized drawing to be worthwhile in getting a well-shaped wing. Build the wing flat and then break the spars and leading and trailing edges and add the 3" dihedral to each tip. The $^{1}/_{16}$x$^{1}/_{16}''$ bamboo tips are semicircular and are reënforced with pieces of $\frac{1}{8}$x$\frac{1}{8}''$ balsa.

ELEVATOR

Since the elevator is a small version of the wing the same methods of construction should be used. A metal rib template is as useful here as it was in the wing. Notice that dihedral is given to the elevator—an important item in the pusher's stability.

PROPELLER

Follow closely the method of laying off the propeller block. Mark the block carefully with pencil and ruler. The excess wood is cut away as indicated in Step Two of the drawing. Next, the blades should be cut—carefully cutting away the balsa down to the diagonal lines, which are indicated on the ends of the block. Using sandpaper, put a slight "hollow" in the blades. Wrapping the sandpaper around a small bottle will insure a smooth, concave blade. Now turn the propeller over on the other side and cut the blades down to thickness—ranging from $\frac{1}{4}''$ at the center to $^{1}/_{16}''$ at the tips. The exact thickness of the blades is unim- (Turn to page 94)



Flight records and contestants in competitions.

Model Matters

Club notes and news of model organizations.

(In contest tabulations, results are to be read as minutes (to left of colon), seconds, and fractions.)

Junior Aviation League

An interesting meeting of the Junior Aviation League of Boston was held recently. Captain Richard E. Cobb, commanding officer of the air corps at East Boston Airport, took the Junior Aviation League members on an imaginary early-morning flight over Boston to gather weather-forecasting data. Every morning, in practically all kinds of weather, these weather planes carry out these flights, getting the data that is necessary to make upper-air forecasts that air lines and fliers find so necessary.

Another interesting highlight of this gathering was the talk of Gunnar Munnick, an early model builder, who traced the progress of the hobby from the time he first began it, over twenty years ago, up to the present time.

Chicago Aeronuts

The Chicago Aeronuts have an unusual feature of their meetings. A one-hour session of basket ball follows each meeting. Club members seem to feel that this is an important part of their activities. It provides a means of diversion to the members, most of whom attend school or are employed, and since they spend much of their spare time with models, these sessions of basket ball help keep them in trim. Basket ball is the natural recreation, since the meetings are held in the park gymnasium. However, other clubs should follow this idea. Regardless of where meetings are held there is always some sport which could be played after the more serious business of the meeting has been disposed of.

Any one who would like to learn more of the Aeronuts' activities should contact Tom Cunningham, 1039 Hollywood Ave., Chicago, Ill. And for the benefit of Chicago Modelers who are interested, the Aeronuts meet at Gage Park, 2411 W. 55th St., at 2:30 p. m. on Saturdays.

Linden Model Club

The Linden Recreation Commission of Linden, New Jersey, has sponsored a model club. The club was organized under Frank Krysiak, superintendent of recreation in Linden. This was two years ago. Since then the club has been growing. At present there are twenty-three active members. Weekly contests are held in the local armory. These contests serve as preparation for the Linden City Indoor Meet held late in March. Low ceilings keep the flight times low, but in no way do they lower the spirits of the contestants.

Francis Ryan, a member of the club, is the Union County champion as well as the city indoor champion, having won both these contests last year. Outdoor honors are held by Richard Egels. His records are 7m 2s for the hand-launched fuselage event and 5m 30s for the Rise-Off-Ground fuselage record.

Gas models form a substantial part of the club's model diet. Their first gas model, completed some time ago, has made twenty-nine successful flights, with only a few broken propellers—no further damage despite several tree landings.

Members of the Linden, N. J. Club display three typical gas jobs. This active group is under the sponsorship of the Linden Recreation Commission.

Keystone Contest Results

The Flying Keystone Model Airplane, of Allentown, Pa., had a busy month during January. On January 9th the fourth indoor meet produced six local records. Following is the tabulation of the results:

R. O. G.

Russell Fahringer	4m 12s
George Micott	3m 1s
Elwood Matten	38.5s
Richard Waidelict	18s

Glider

George Micott	19s
Martin Schulte	13s
Elwood Matten	10s
Charles Wiedes	7.5s
Richard Waidelict	7.5s

Stick

George Micott	3m 8s
Russell Fahringer	2m 56s
Martin Schulte	1m 2s
Sterling Schaffhauser	51s
Elwood Matten	34s
Richard Waidelict	19s

Cabin Fuselage

George Micott	55s

On January 26th the second solid-scale contest was held with the following results: First, Charles Wiedes—Ryan "NYP," 82 points; second, Richard Metzger—S. E. 5, 79 points; third, Russell Fahringer—Martin Bomber, 71 points.

Judges for all the events were Ernest Shaffhauser, Albert Baus, and Russell Greisemer.

Oklahoma Model Club

During the past year the organization of model clubs mushroomed to such an extent that the occurrence has become commonplace. However, when a model club is founded with the intention of progressing to light-plane activity, it is news.

Such a club is successfully operated in Sayre, Oklahoma, and by exhibitions there has been promoted a feeling of "air-mindedness." Encouraged by the enthusiasm of the townspeople, this progressive group took the logical step of developing a club plan to operate a light plane.

Departing from the usual procedure, since they wished to add to the individual technical knowledge and interest, they decided to construct their own ship, a project deserving success.

In most instances models provide the in-between stage to the future pilot, technician or other aviation vocations. To progress beyond that step is the greatest obstacle. Unless he has funds at his disposal, the individual is not able to enter the regular aviation schools. The forming of a club and the active participation in its program furthers the individual's chances, a group being financially capable of operating a light plane on the club plan or of carrying on some other furthering idea.

As with this Oklahoma group the members do not wish to merely fly, but to experience the long-familiar feeling of personal accomplishment. Since constructing a plane would afford this and other requirements of general and individual interest, such a step holds promise.

However, the well-planned program must take into consideration the licensing of aircraft. Accordingly, information should be obtained from the department of commerce concerning requirements.

POPULAR SPORT PLANE

TAYLOR CUB

The simplicity of the Taylor Cub makes building this model a pleasure to beginner or expert.

A solid scale replica of another light plane which has caught the public fancy and which will make an attractive addition to any collection.

by William Winter

THE TAYLOR CUB needs no introduction, it being one of the most popular of the light planes now on the market and a familiar sight at every airport.

Stealing the thunder of the automobile industry, the Cub sales have grown until carrier trailers have been pressed into service to speed up deliveries. Alert to the potentialities of the light-plane market, this popular ship is available on the time-payment plan. Club ownership, in many cases, enables all, who have been prevented from flying by the prohibitive cost, to spread their wings for a comparatively negligible amount.

The cost of operation compares favorably with that of even the lightest automobile.

DIRECTIONS FOR BUILDING

Dimensions of all materials are listed at the close of the article.

Trim a soft balsa block to the required outside dimensions of the fuselage. On the largest side, draw the profile of the body and cut away the surplus wood. On the narrow surface of the partly shaped block, mark the top outlines of the body and again cut away the excess balsa. Shape the fuselage in accordance with the given cross sections and sand thoroughly. At this stage the cabin may be cut out, should the builder desire it.

The tail surfaces are marked on $^1/_{16}''$ sheet balsa and cut out. Each piece is sanded to a satin finish and the edges rounded. By using headless, straight pins as directed by the plan, each unit is held firmly in position while the cement is drying, this innovation making for a longer-lasting model.

The wing panels, one left and one right hand, are cut to the required outline from a full cut of $^1/_8''$ sheet balsa and shaped to the given rib section. Sand the surfaces and edges smooth. Each panel is held by the bamboo peg, illustrated, as well as by the thickened cement, the supporting struts being streamlined from scrap strip balsa and cemented in position while the model is inverted.

The landing-gear struts of pointed bamboo pieces are cemented and stuck in position. The floats, which are optional with the builder, may be shaped from soft balsa, and attached with bamboo struts.

The propeller is carved from a scrap and is mounted on a pin so that it is free to turn.

To finish the model, give it a filler coat of white shellac or clear varnish, to close the pores. The number of coloring coats given the surface depends on the builder's opinion, although one is usually enough for the average model. The windows are white with black trimming.

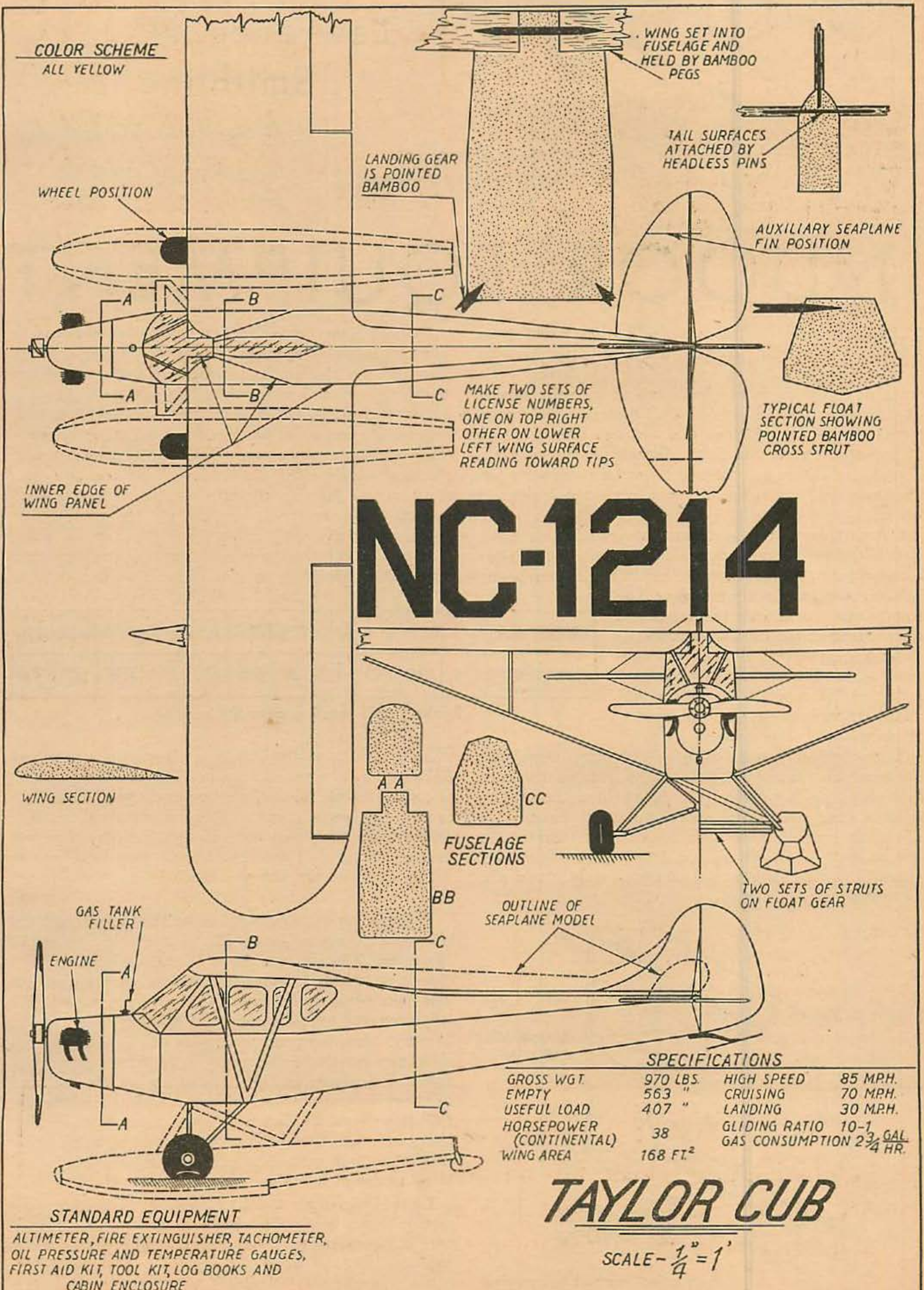
BILL OF MATERIALS

1 $5\text{x}1^1/_4\text{x}^5/_8''$ soft balsa block.
1 $^1/_8\text{x}2\text{x}12''$ soft balsa sheet.
1 $^1/_{16}\text{x}2\text{x}12''$ hard balsa sheet.
1 pr. $^3/_8''$ wheels.
1 pc. flat bamboo.
1 vial cement.
Small quantity clear dope, varnish, or white shellac.
$^1/_2$ oz. yellow dope or lacquer.
Pins and sandpaper.

ARE YOU INTERESTED IN SOARING?

Sailplaning and gliding are becoming popular again. How many AIR TRAILS readers would like an article on Sailplanes? How many would like a department? Drop me a line, will you?

—F. Orlin Tremaine, Editor


COLOR SCHEME
ALL YELLOW
WING SET INTO FUSELAGE AND HELD BY BAMBOO PEGS
TAIL SURFACES ATTACHED BY HEADLESS PINS
LANDING GEAR IS POINTED BAMBOO
WHEEL POSITION
AUXILIARY SEAPLANE FIN POSITION
A
B
C
A
B
C
MAKE TWO SETS OF LICENSE NUMBERS, ONE ON TOP RIGHT OTHER ON LOWER LEFT WING SURFACE READING TOWARD TIPS
TYPICAL FLOAT SECTION SHOWING POINTED BAMBOO CROSS STRUT
INNER EDGE OF WING PANEL
NC-1214
WING SECTION
A A
CC
FUSELAGE SECTIONS
BB
TWO SETS OF STRUTS ON FLOAT GEAR
OUTLINE OF SEAPLANE MODEL
GAS TANK FILLER
ENGINE
A
B
C
A
C

SPECIFICATIONS

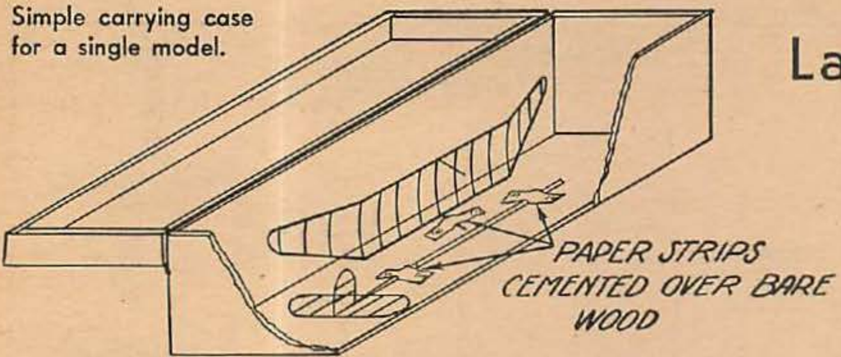
GROSS WGT.	970 LBS.	HIGH SPEED	85 M.P.H.
EMPTY	563 "	CRUISING	70 M.P.H.
USEFUL LOAD	407 "	LANDING	30 M.P.H.
HORSEPOWER (CONTINENTAL)	38	GLIDING RATIO	10-1
WING AREA	168 FT.^{2}	GAS CONSUMPTION	$2\frac{3}{4}$ $\frac{\text{GAL.}}{\text{HR.}}$

TAYLOR CUB

SCALE – $\frac{1}{4}'' = 1'$

STANDARD EQUIPMENT

ALTIMETER, FIRE EXTINGUISHER, TACHOMETER, OIL PRESSURE AND TEMPERATURE GAUGES, FIRST AID KIT, TOOL KIT, LOG BOOKS AND CABIN ENCLOSURE


Simple carrying case for a single model.

Lawrence N. Smithline *presents a practical method for carrying models*

INDOOR EQUIPMENT

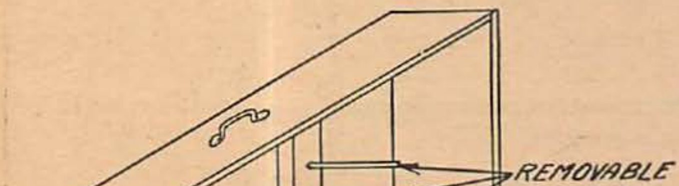
EVERY MODELIST, whether he be an indoor or outdoor builder, has been bothered by the question of carrying cases at some time in his career. This question strikes the indoor builder more severely, because of the nature of indoor ships. Obviously, an indoor model cannot be safely carried through the streets in one's hands, whereas the chief objections to carrying outdoor models open are the stares of the passers-by and the occasional rainstorm which catches the builder at the field.

Carrying cases are as variegated as models themselves. Anything from a complicated balsa "coffin" with various compartments, to the discarded wholesale flower boxes, can be seen in the local armories. The most popular, or at least the most used, are, of course, the cardboard cases, as they are the cheapest and easiest to obtain. Local florists are only too glad to get rid of a box—that they would throw out anyway—for a consideration of ten to twenty-five cents.

RUBBER SIZE	1/32" × 1/30"	3/64" × 1/30"	1/16" × 1/30"	5/64" × 1/30"	3/32" × 1/30"	7/64" × 1/30"	1/8" × 1/30"	9/64" × 1/30"	5/32" × 1/30"	11/64" × 1/30"	3/16" × 1/30"
WINDS/INCH 2 STRANDS	215	188	150	140	130	120	113	111	105	97	91

Rubber table showing capacity windings.

The weight of a cardboard box is, of course, very light; however, it is rather weak and must be carried with care. "Beefing it up" by putting in wooden strengtheners, reenforcing the corners and shellacking it will increase the life of the box and save your nerves when bumping the box around. A cardboard box fitted up in this manner should suit most any model builder, except those who can afford a better one.



A practical method of carrying wings safely.

If you are the type of person whose æsthetic sense is outraged by carrying a box through the streets, and you are satisfied with a small carrying case, you may buy one of those cheap valises which sell for about $1.00. The standard size seldom exceeds thirty inches; however, larger ones can be bought at a much greater expense. Carrying-case manufacturers will make up one to your specifications for about $5.00. If you can convince three other model builders that they should have a large, strong, light, fiber case, you can get four much more cheaply than one.

If you believe that your models rate something better than a cardboard case and think that a wooden coffin is what you want, you can make a plywood one for about $3.00 and a balsa one for about $7.00. In this you can, of course, include all the little do-jiggers you please, such as propeller compartment, rubber compartment, etc. The chief virtue of the balsa box is weight (or should we say lack of weight). However, its cost may force you to decide that you are strong enough to carry a plywood box.

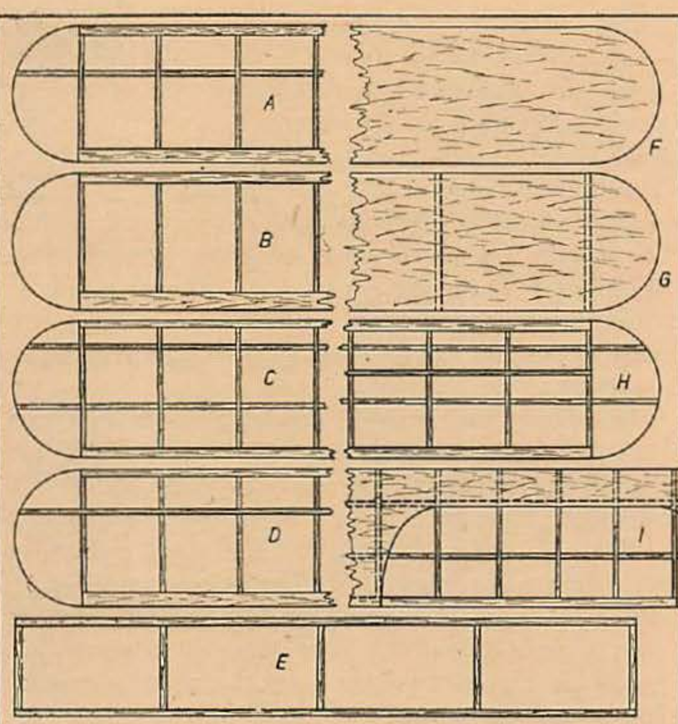
In designing your plywood or balsa box you must decide what type you want. Mr. Whalen, of Springfield, Mass., has a "skyscraper" box. It's tall and narrow, with dowels on which to support wings in the flat position. The more ordinary flat type will carry fewer models, but it is preferred by the majority of builders as it is easier to carry. Another point which you should take into consideration is whether or not you prefer to carry your rubber and winder and other modeling tools in the same box, or, as most builders do, in another, separate kit. Fastidious builders have separate compartments in their boxes in which they keep propellers, extra motor sticks and booms, and extra film. If you are one of that class, by all means include them in your box.

Lastly, you might consider methods of holding your models in the box. Most builders merely stick them in with sticking paper, that is, run a strip of paper across any open piece of wood of the wing or fuselage. Some of the more fortunate builders, who have cars in which to carry their boxes, merely lay the (Turn to page 96)

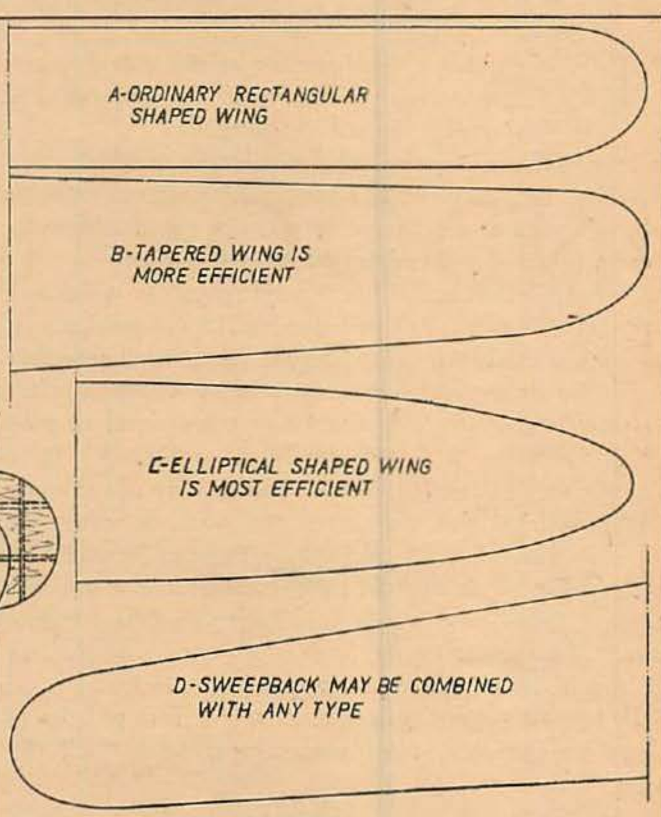
Builder's Guide

Wings

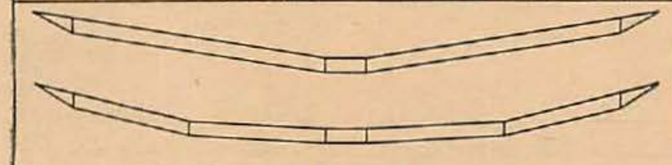
by William Winter



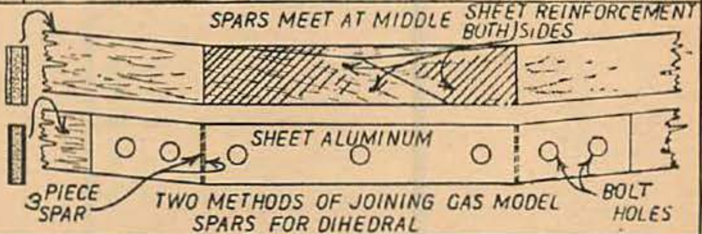
A-MONOSPAR
B-EDGE SPARS
C-CONVENTIONAL
D-MONOSPAR ON UPPER SURFACE
E-STRIP OUTLINED R.O.G. WING
F-FLAT SHEET TYPE
G-CAMBERED SHEET TYPE USES A FEW, HEAVY, SHAPING-RIBS
H-MULTISPAR
I-SHEET REENFORCED


A-ORDINARY RECTANGULAR SHAPED WING
B-TAPERED WING IS MORE EFFICIENT
C-ELLIPTICAL SHAPED WING IS MOST EFFICIENT
D-SWEEPBACK MAY BE COMBINED WITH ANY TYPE

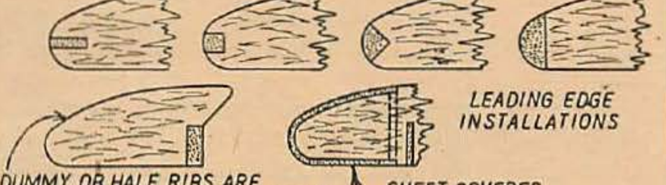
STANDARD WING OUTLINES



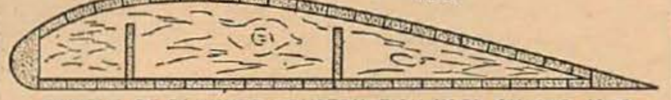
TWO USUAL DIHEDRAL ARRANGEMENTS



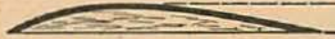
TWO METHODS OF JOINING GAS MODEL SPARS FOR DIHEDRAL



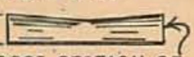
LEADING EDGE INSTALLATIONS



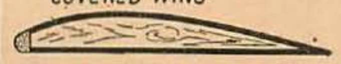
SAMPLE OF PLANKED CONSTRUCTION USED ON GAS JOBS STRIPS ARE 1/8 THICK BY 3/8 OR MORE WIDE



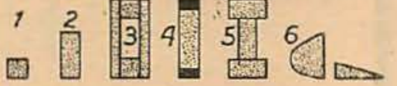
SINGLE SURFACED BALSA COVERED WING

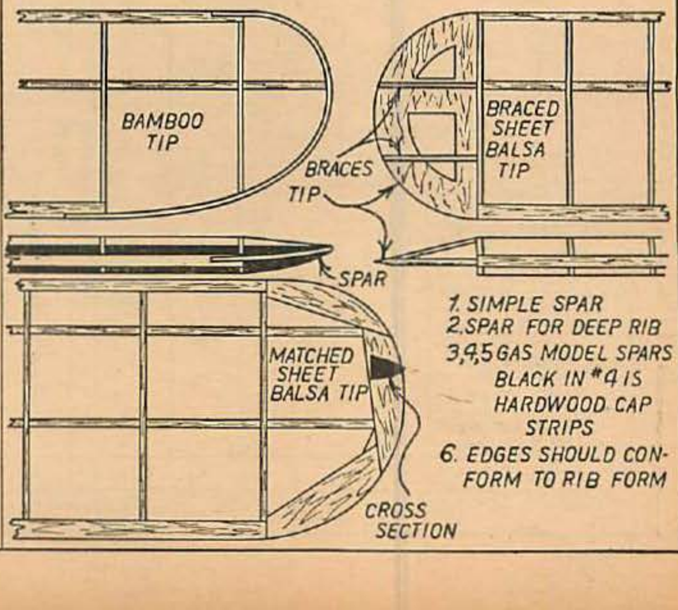


CROSS SECTION OF DIHEDRAL BLOCK FOR SHEET COVERED WING IS RIBLIKE



DOUBLE SURFACED BALSA WING





1. SIMPLE SPAR
2. SPAR FOR DEEP RIB
3,4,5 GAS MODEL SPARS BLACK IN #4 IS HARDWOOD CAP STRIPS
6. EDGES SHOULD CONFORM TO RIB FORM

Balsa Wood Testing Machine

by Howard Ide

HOW often have you painstakingly built a model only when flown to have it reduced to a shoddy-appearing job because of minor breakages?

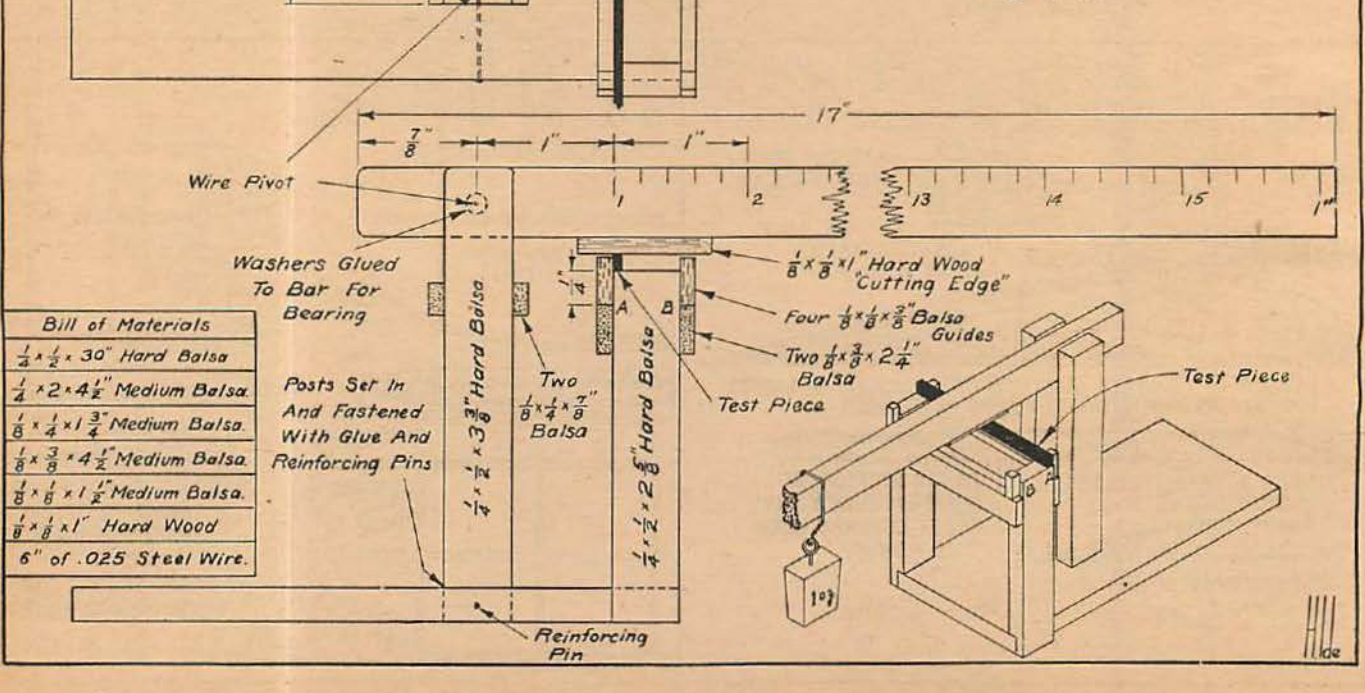
Despite the use of seemingly high-grade materials, this is a frequent occurrence. Landing jolts often appear to cause breakage at unusual places in the framework. Really, this is due to weak spots in the wood.

Of course, the careful builder examines the individual strips, but, despite the closest scrutiny, hidden weaknesses are seldom disclosed. The familiar "finger-nail squeeze" is inferior to an actual material strength-testing device.

The strength tester is purposely constructed of materials found in any model builder's workshop. It is strong enough to snap a ¼-inch-square strip of medium-hard balsa, yet delicate enough to measure accurately $^{3}/_{64}$-inch soft balsa. A miniature tester can be made for lighter-balsa stock used in indoor models, or a heavier, stronger tester can be built for larger pieces used in gas jobs. The standard tester uses a 1¼-ounce weight and the special testers correspondingly sized weights.

To operate the strength tester, the test piece of balsa is placed in position (most pieces in position "A," the smaller, lighter pieces in position "B") and the weight slowly moved outward on the arm until the test piece snaps. Depending on the strength of the test piece, the small, large, or both weights may be used in the test. The reading of the weight at the position at which the test piece breaks gives the strength of the piece in ounces of pressure. Of course, this is using the 1-ounce weight. When the 4-ounce weight is used, the pressure is 4 times the scale reading. To test small, light pieces, place the piece in position "B" and multiply the scale reading by $^{2}/_{3}$ to get the correct reading.

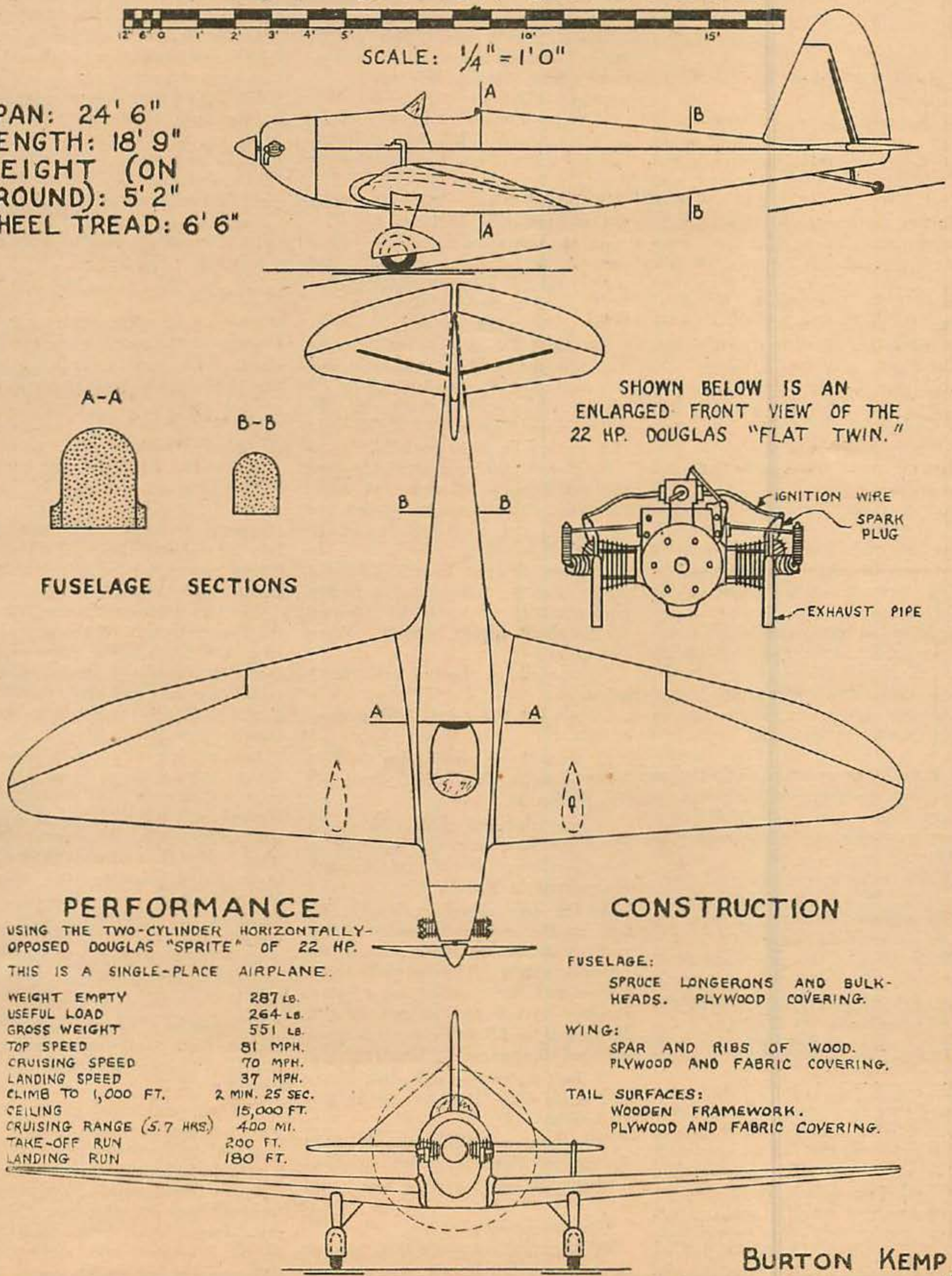
In ordinary use in model building, the tester is used with the weights in one position. Only pieces which pass this given strength test are used in that specific part of the model; thus, pieces to be used for spars or longerons must pass a higher strength test than those to be used for stringers or cross braces. The truly amazing difference in strength of two apparently identical pieces, or even opposite ends of the same strip, will soon convince you of the importance of the tester, and you will wonder how you dared to trust your wood in a model without first testing it.


Reinforcing Pin
1/8
Guides
Test Piece
Prefered Weights: One And Four Ounce.
BASE 1/4 x 2 x 4 1/2" Medium Balsa
7/8"
3/8
1/4 x 1/2 x 17"
17"
7/8"
1"
1"
Wire Pivot
1
2
13
14
15
1"
Washers Glued To Bar For Bearing
1/8 x 1/8 x 1" Hard Wood "Cutting Edge"
1/4
A
B
Four 1/8 x 1/8 x 3/8" Balsa Guides
Two 1/8 x 3/8 x 2 1/4" Balsa
Test Piece
Test Piece
Bill of Materials
1/4 x 1/2 x 30" Hard Balsa
1/4 x 2 x 4 1/2" Medium Balsa.
1/8 x 1/4 x 1 3/4" Medium Balsa.
1/8 x 3/8 x 4 1/2" Medium Balsa.
1/8 x 1/8 x 1 1/2" Medium Balsa.
1/8 x 1/8 x 1" Hard Wood
6" of .025 Steel Wire.
Posts Set In And Fastened With Glue And Reinforcing Pins
1/4 x 1/2 x 3 3/8" Hard Balsa
Two 1/8 x 1/4 x 7/8" Balsa
1/4 x 1/2 x 2 5/8" Hard Balsa
B
1 oz
Reinforcing Pin
HIde

THE TIPSY S

POPULAR BRITISH LIGHTPLANE

SPAN: 24' 6"
LENGTH: 18' 9"
HEIGHT (ON GROUND): 5' 2"
WHEEL TREAD: 6' 6"



SHOWN BELOW IS AN ENLARGED FRONT VIEW OF THE 22 HP. DOUGLAS "FLAT TWIN."

PERFORMANCE

USING THE TWO-CYLINDER HORIZONTALLY-OPPOSED DOUGLAS "SPRITE" OF 22 HP.

THIS IS A SINGLE-PLACE AIRPLANE.

WEIGHT EMPTY	287 LB.
USEFUL LOAD	264 LB.
GROSS WEIGHT	551 LB.
TOP SPEED	81 MPH.
CRUISING SPEED	70 MPH.
LANDING SPEED	37 MPH.
CLIMB TO 1,000 FT.	2 MIN. 25 SEC.
CEILING	15,000 FT.
CRUISING RANGE (5.7 HRS.)	400 MI.
TAKE-OFF RUN	200 FT.
LANDING RUN	180 FT.

CONSTRUCTION

FUSELAGE:
SPRUCE LONGERONS AND BULKHEADS. PLYWOOD COVERING.

WING:
SPAR AND RIBS OF WOOD. PLYWOOD AND FABRIC COVERING.

TAIL SURFACES:
WOODEN FRAMEWORK.
PLYWOOD AND FABRIC COVERING.

BURTON KEMP

THE BLACK HAWK

(Continued from page 14)

"A black hawk," Barnabas said, dully. "Does it mean anything to you, Bill?"

"Not a thing," Bill said. Then he drew in his breath with a sharp hiss, as a thought came to him. He stood staring at the floor until the shrill scream of a police siren brought him out of his reverie.

II—ANOTHER THEFT

BILL BARNES scowled viciously at his own reflection in the mirror as he knotted a plain, dark-blue necktie and slipped into a tweed waistcoat and jacket.

He was thinking about that night in October, 1936, the night of the Barnabas robbery. Every time he thought about it he got sore. The police had turned up a few strange footprints around the grounds and a few more on the observation tower on top the flat-roofed house.

That was all. The robbers, or robber, had come from nowhere and had gone back as silently and easily as they had come. No trace of any of the jewels had ever been found. The thing still remained a mystery.

On top of that his own business had gone from bad to worse. His men, his shops, his planes had been idle most of the time. Mentally and morally, he and his men were at the lowest ebb he could ever recall.

He kicked a waste-paper basket across the room as a knock sounded on his door. He muttered something under his breath, then called, "Come in!"

"Shorty" Hassfurther, Bill's chief of staff, opened the door and came into the room. His broad, Pennsylvania-Dutch face was wreathed in smiles as he tossed a newspaper on Bill's desk.

"You look about as cheerful as one of the gargoyles on Notre Dame," he said.

"I look twice as cheerful as I feel," Bill said. "What's on your mind?"

"That paper," Shorty said, pointing. "Take a look at the headlines."

Bill grabbed at the paper and read:

HALF MILLION MIAMI THEFT
LIKENED TO BARNABAS ROBBERY

His eye skimmed down the column to read that the home of Julian Leonard at Coconut Grove, outside Miami, had been burglarized of its invaluable collection of gems. The robbers had come and gone without being seen. A servant had been knifed to death. There were no clues except some strange footprints on the estate. A plane had flown low over the house the night of the robbery.

Bill's eyes were gleaming as he lifted his head and looked at Shorty.

"It proves one thing," he said. Shorty lifted his eyebrows. "The plane had something to do with it. It sounds just like the Barnabas job. The footprints, the plane—and nothing else."

"Nuts!" Shorty said. "How did the guy get into the house and rob and get away again? Did he land on the dining-room table?"

"I've been trying to figure that out for three months," Bill said. "But it's all there if you're smart enough to figure it out."

"I'm not," Shorty said. "I'm what the boys call a dumb cluck. I——"

He stopped speaking as the bell of one of the telephones on Bill's desk pealed and Bill lifted the receiver.

"Yeah, Bill speaking, Tony. . . . Who? . . . Put 'em on.

"O. K.," Bill said. "I'm listening. You tell me." He stood with half-closed eyes while he listened to the voice at the other end of the wire. Finally, he spoke again. "O. K.," he said. "I'll be there in three hours."

He slapped the receiver on the hook and then lifted it off again and jiggled the hook. His face was flushed and eager now and Shorty could feel his own heart pounding.

"Gimme Scotty, Tony," Bill said. "Hello, Scotty. Run out the Lancer. She's checked? . . . O. K. I'll want her in about fifteen minutes. Warm her up."

"What's all the shootin' fer?" Shorty asked.

"Where are you going?" Bill snapped at him.

"I thought we were going to New York to see a show," Shorty said. "I thought you said——"

"Cancel it," Bill said. "Wipe the grease off your face and slip into an overall—a heavy one; it's cold to-night. We're going to Miami."

As the door closed on Shorty, Bill took up the newspaper again and hurriedly went through the account of the Leonard robbery. Then he yanked open a door of a closet, pulled out a heavy, fur-lined overall and stepped into it. He yanked the helmet he was putting on his head off again, as his telephone rang.

"I don't know who it is, Bill," Tony said in his ear. "He won't say or give his business."

"Put him on," Bill snapped. "I'm shoving for Miami in a few minutes."

"Hello, Barnes?" a voice said in his ear.

"Barnes speaking."

"This is just a friendly little gesture, Bill," a voice Bill did not recognize said. "I want to warn you to keep out of that Leonard affair in Miami. Keep out, or else, Barnes."

"Listen!" Bill shouted into the mouthpiece.

"No!" the voice came back at him. "I didn't call you up to listen. I called you up to tell you. Good-by."

The receiver at the other end of the line clicked in Bill's ear with a finality that was conclusive.

Bill jiggled the receiver up and down on the hook frantically. Perspiration broke out all over his body from the heat of the overall he was wearing and from excitement. When Tony Lamport came on the line he bellowed in his ear. "Trace that call, Tony!" he shouted. "I'll call you back on the radio within a half hour. Get it?"

"O. K., Bill. I'll start checking," Tony said.

Shorty was talking to Scotty MacCloskey on the apron when Bill joined them. He listened to the muted roar of the twin Diesels for a moment, then nodded his head.

"She'll do," he said. "You checked the ammunition?"

"She's O. K., boy," Scotty said. "You'll keep in touch with us?"

"All the time," Bill said. He mounted the accommodation ladder and slipped into the forward cockpit. He plugged his ear phones into his helmet as Shorty climbed into the after cockpit.

The three thousand horses propelling the Lancer took it off the ground in a long, low climb. The flaps came up and the sesquiplane landing gear slid up into the belly and wings as Bill stuck the nose of the roaring ship into the snow.

As the ship nosed into the great, sticky drops of snow, Long Island became a dim mass of blurred lights behind them. When Bill flicked off his landing lights the world became a huge, black void. He continued to climb until he had fifteen thousand feet under him. He knew that after a bit the weight of the snow on his wings would begin to tell.

"Just the kind of a night I've always wanted to start for Miami," Shorty said into his intercockpit telephone.

Bill grunted. "We'll set her down at Dinner Key. This bird Leonard's estate is at Coconut Grove, not far from there."

The air was causing his compass needles to jiggle in crazy fashion. From each dial on the instrument panel came a pale, phosphorescent glow. The gyro compass, earth-inductor compass, and turn-and-bank indicator were acting like toy acrobats on a string. As the fury of the snow and wind increased, he tightened the locking lugs on the overhead hatch to keep out the bitter cold.

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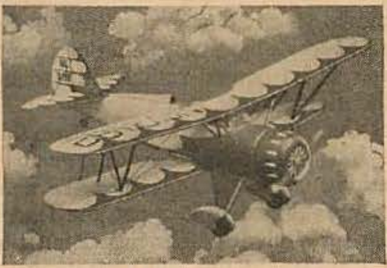

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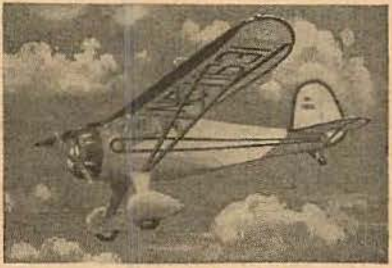

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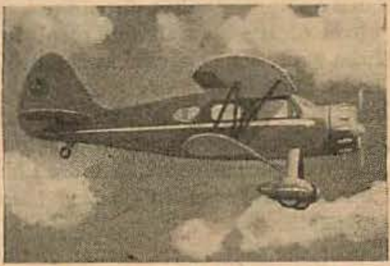

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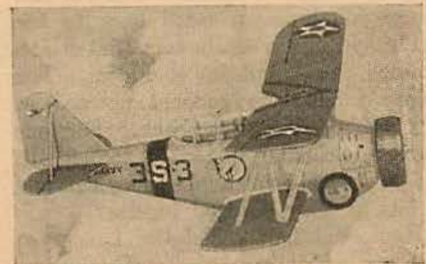

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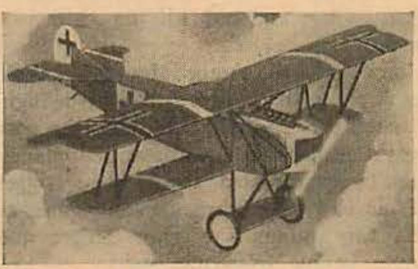

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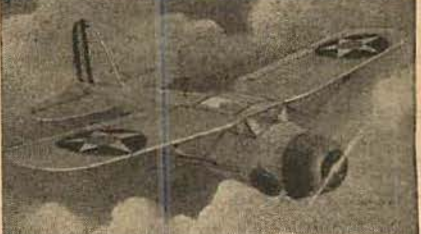

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The sturdy ship dropped into pocket after pocket. They fastened their safety belts and were slapped back and forth in their seats. From then on, every moment was a fight. Every twist and lurch and drop had to be compensated for. They climbed upward at a terrific speed on a rising current of air and were smashed down on the other side like an ocean liner riding the swells.

"How're you going?" Shorty said in Bill's ear.

"Just as the crow flies," Bill growled, gasping for breath. "I told 'em I'd be there in three hours."

"What about the Black Hawk?" Shorty asked. "Did the paper say anything about the trademark you found stamped on the wall after the Barnabas robbery?"

"I didn't notice," Bill said. "But I'll bet my pants we find it there some place."

"You want to keep your pants on on a night like this," Shorty pointed out.

"We'll be out of this in an hour," Bill said. He tried to peer out to the end of the wing tips but he could not see them. Even his running lights were obscured by the driving snow. He checked his position and saw that he should be on the route of a radio beacon, but he could not pick it up. He could not see any of the two-million-candle-power beacons that were supposed to be flashing beneath him. They were locked in a world of their own that was moving at four hundred and fifty miles an hour into a fifty-mile wind.

As his altimeter and turn-and-bank indicator went mad he saw a dim mass rise out of the snow ahead of him. His breath sucked in through his blue lips as he yanked the stick back into his stomach and brought the big ship over in a vertical bank.

He pulled out of a flat spin and tried to peer earthward. Abysmal darkness stared back at him. He pulled the parachute flare lever because he couldn't be sure of his instruments. The flare took a dizzy course earthward, to light up a forest thick with snow. At the outer edge of the light from the flare he could see the dim outline of a ridge. He realized that he had missed sticking his nose into it by a miracle. He cleared his throat and spoke into his telephone.

"Did you notice that ridge?" he asked Shorty.

"Notice it?" Shorty growled. "Listen! I think it's stuck in my throat. If it isn't it's my heart!"

"We'll be out of this in a few minutes," Bill said, his tight lips relaxing.

And five minutes later the black storm clouds were scudding northward behind them. The moon cast a silver glow over the great marshes and rivers of the lowlands. They settled back in their bucket seats and loosened the lugs in the overhead hatch.

Suddenly, they were both aware that the two Diesels in the nose of the Lancer were not roaring alone. The high-pitched whine of diving planes penetrated their consciousness.

"Where are they, fella?" Bill shouted into his microphone.

"They're coming down on our starboard quarter!" Shorty screamed. "Three of 'em and they're getting the range with tracers. Throw her out of line, Bill, or they'll murder us!"

For one fleeting instant Bill looked up and back over his right shoulder. Fire and smoke belched from the exhausts and the machine-gun troughs of the three diving ships. He saw that they were diving at an angle that meant they were going to continue their dive underneath him, after they had driven a hail of lead into the belly of the Lancer.

He yanked the control column back into his stomach and kicked his rudder until it slapped against the stop. The Lancer seemed to gasp at the tremendous strain put upon it. But the nose came up and the ship rolled over on its side. As its speed decreased until it was in a spin, Bill centralized his controls after one turn and flattened out. Not a single bullet from the three diving monoplanes touched the Lancer, so great was the speed of that flick roll.

"Zowie!" Shorty shouted in Bill's ear phone. "Don't do that again at that speed. I nearly blacked out. I'm sliding my hatch forward to get at the swivel gun. Blast your tail around when you go by 'em and I'll pin their ears back."

The gale that raced by the Lancer as it plunged downward rose to a high-pitched crescendo as Bill stuck the nose on the leader of those three monoplanes. His finger caressed the electric trigger of his two .50-caliber machine guns, as the tiny monoplane grew larger and larger in his telescopic sight.

At two hundred yards away, he clamped down on his gun trip. At the same instant the moon slid behind a bank of clouds and made of the night a dungeon. Bill yanked back on the control column. The belly of the Lancer seemed to dance on the nose of that leading monoplane for a split fraction of a second.

Then, it was clear and Bill brought it up and over on its back and whip-rolled it back to normal flight. He could see the blue-and-orange stars from the exhaust pipes of the three ships far off to his left and knew that they were trying to get the advantage of height.

Bill yanked his infra-red-ray telescope out of its well, as the three ships banked around and started to dive again. Long streamers of flame, like fiery ribbons, danced behind them as they plunged out of the heavens. Then, the noses of the three ships belched fire and lead as they converged on the Lancer.

Bill's face was contorted as he tried to get one of the plunging ships under his sights for a fleeting moment. But their speed, combined with his own, was too great. He yanked the stick back into his stomach and opened the throttles, determined to get above them this time. He could feel the Lancer quiver and buck as bullets drilled into her. He heard a roar of anger and a high-pitched curse rip from Shorty's lips as bullets drummed into his instrument panel. He heard Shorty's light .30-caliber gun yammering as he poured round after round at the diving ships.

As they came out of their dive this time Bill brought the Lancer around in a flashing chandelle and stuck the nose down. Again he picked out the leader of the three planes. He picked out the ship clearly through his infra-red-ray telescope this time.

The air churned with flame and roaring motors and bullets as they raced toward one another. Bullets drove through the wings of the Lancer and crept toward the main float cuddled in the belly of the fuselage.

Then, Bill altered his aim ever so little and froze his finger on his gun trip. A red inferno came to life as his two Brownings began to chatter their song of death.

Bill saw the face of the leader of the little V through his telescope. It was white and strained and drawn. And then it wasn't there.

His powerful bullets drummed into the engine housing, raced back to the windshield and literally tore that white, strained face from its shoulders. The enemy monoplane zoomed upward as Bill yanked his stick back. For one horrible, sickening instant it seemed the two ships could not avoid being smashed to bits as they plunged together.

Then, Bill half rolled the Lancer so that one wing tip of the madly careening monoplane just scraped the belly. In another instant he was away and clear. The nose of the stricken monoplane dropped and the tail began to whirl as it plummeted toward the endless marshland below.

Again Bill heard the yammer of Shorty's gun and a wild, exultant shout come from his lips.

"I got one of 'em right where he sits down, Bill!" he shouted. "I could tell by the way he yawed. Bring her up and over in an Immelmann and you'll have 'em both. They can't decide whether they've had enough."

Bill looked back over his shoulder and saw their exhausts speeding away to the west. For a moment he fought with himself. He wanted to stick the Lancer on their tails and give them what they had asked for.

The Snorter tried to climb out of the water and onto the beach, like some huge monster. There was a horrible wrenching sound and a thud——

"Bill!" Shorty shouted in his telephone. "Open her up or they'll get away from you. One of those fellows smashed my instrument panel and cut my face all to hell. I owe him more than a couple of shots in the pants."

"No!" Bill snapped. "They've had enough. It will give the Black Hawk something to think about." He glanced at his chronometer as he brought the Lancer around and opened the throttles wide. "I've got to get to Miami."

III—CLUES

JUST AFTER the great, sprawling city of Jacksonville flashed beneath the Lancer's wings, Bill made contact with Tony Lamport on his radio.

"O. K., Bill. Tony speaking," he said. "Where are you?"

"Just over Jacksonville," Bill replied. "Tell Scotty to have all our ships ready to take to the air on a second's notice. Check the carrier-transport, too, and Sandy's Eaglet. Get 'em all ready to go. Three wicked little monoplanes jumped me above the marshland of North Carolina. I got one of 'em and he peeked too steep into the ground. Report it. What did you find out about that telephone call?"

"It came from the University Club, Bill," Tony said.

"The University Club!" Bill shouted. "You couldn't find out from the attendant there who put it in?"

"No," Tony said. "He was a dumb cluck and——"

"Or very bright," Bill broke in. "We'll trace it. In the meantime get a list of all the members of the club. We'll be in Miami in a little bit. You can make contact with me at Dinner Key. I'm signing off."

"O. K., Bill. Signing off." Tony's voice trailed away.

"Did you hear that conversation?" Bill asked Shorty.

"Yeah," Shorty said. "The old boys at the University Club are getting playful."

A half hour later those two indescribable cities—Miami and Miami Beach—leaped out of the rolling Atlantic ahead of them.

Bill picked up the illuminated wind sock on the hangar a few minutes later and circled the immense administration building twice. He set the Lancer down on the waters of Biscayne Bay and roared toward the landing ramp. He taxied up carefully, until the main float of the Lancer was on the inclined turntable. The turntable came up and swung halfway around. An attendant rolled a short flight of steps up to the door and Bill climbed out to shake hands with Steve Hamilton, the operations manager.

"Check her over and fill her up, please," Bill said. "I don't know when I'll want her. Where can I get a taxi?"

"There's a police car waiting for you on the other side of Hangar Number 1," Hamilton said.

The police car turned in through a buginvillæa-covered driveway about a mile down Biscayne Boulevard. A quarter of a mile back from the boulevard the car came to a halt before a long, low stucco house of Spanish design.

A man with broad shoulders, iron-gray hair and a brick-red face came down the steps as Bill and Shorty climbed out. Bill didn't have to ask him his name. He knew he was the chief of police.

"Your name is Clarkson," Bill said, as he put out his hand. "I've seen your photograph. This is Mr. Hassfurther, Shorty."

"I'd know both of you if I saw you in Shanghai," Clarkson said. "Your faces are famous."

"What is this? A mutual-admiration club?" the man who had followed Clarkson down the steps asked.

"This is Mr. Leonard," Clarkson said. "Mr. Julian Leonard."

Bill looked at the man with more than a little curiosity as he shook his hand. He saw a man with deep-set, black eyes, black hair and a swarthy complexion.

As two more men joined them Clarkson introduced them as his two crack detectives.

"Let's sit down on the terrace," Julian Leonard said. "You probably want to know why we asked you to come down here, Mr. Barnes."

"I think I already know," Bill said. "But what puzzles me is why you didn't ask Caleb Barnabas to come."

"I did," Leonard said, when they were seated. "I talked to him for some time, but he refused to come. He suggested that you knew as much about the affair at his place as he did, and added that this sort of thing was more in your line."

"But why wouldn't he come, under the circumstances?" Bill wanted to know.

"Well," Leonard said, "as a matter

of fact, Caleb Barnabas and I are not the best of friends. As you know, Caleb and I were both collectors of famous jewels at one time."

"I see," Bill said. "When did the robbery take place, Mr. Leonard?"

"Last night while we were all at dinner," Leonard said.

"Where were the jewels?"

"In a wall safe in my study."

"On the second floor?" Bill asked. "Any one guarding the safe?"

"On the second floor," Leonard said. "One of our watchmen was keeping an eye on the room. I had no one there watching it ordinarily. But Mrs. Leonard and I took a lot of stuff out of a safe-deposit vault a few days ago—some of our most valuable pieces. We intended to put them on the market."

"Any one know you had them in the house?" Bill asked.

"Some one evidently did," Clarkson put in.

"I let it be known through an agent of mine that I was going to dispose of some of the pieces," Leonard said.

Bill nodded his head slowly. "And it was the watchman who was killed?"

"Stabbed through the back," Leonard said. "He died instantly."

"No one but the watchman saw any one strange prowling around?"

"No one," Leonard said. "We haven't been able to find a single clue. The only things we are sure of is that Hunter, the watchman, is dead and the jewels are gone."

"And a few footprints that could belong to any one of a hundred people," Clarkson said.

"The paper said you heard a plane flying low during the time you were eating dinner," Bill said.

"That's right," Leonard replied. "We were all frightfully startled. It sounded for a moment as though it was coming through the window."

"It almost did," Bill said grimly.

"What do you mean?" Leonard asked quickly.

"Do you have a sun terrace on top of your house?" Bill asked, instead of answering the question.

"Why, yes," Leonard said. "The whole top of the house is a sun terrace."

"How much land do you have?" Bill asked. "I mean does it spread out around here, out of sight of the house?"

"Yes," Leonard answered. "I have about ten acres, mostly in gardens and bridle paths."

"Well," Bill said, slowly, "the whole thing is a duplicate of the Barnabas affair. There is no doubt that the same person committed both robberies. I am convinced of that."

"That's why we sent for you," Leonard said. "But who did it? And how did they do it?"

"I don't know who did it, but I think I can tell you how they did it. Before you heard that low-flying plane last night did you hear another one that was reasonably low? I mean, low enough to cause comment? I know you have a lot of planes coming and going here. But this one would be lower than a regular transport from one of the commercial fields or a passenger plane taking tourists over the city. It would have been about eight hundred or a thousand feet up and the motor would have been quite loud."

"Yes," Leonard said. "I think I did. I remember some one remarking that a plane was flying lower than the law permits, before we heard the second one."

"That's it!" Bill said. "I had the same theory about the Barnabas robbery. But I had nothing to prove it. Now I'm certain!" He got to his feet, paced around a table and seated himself again. "I'm certain!" he repeated.

"Of what?" one of the detectives asked.

"It was an air job," Bill said. "The whole thing was done from the air."

"How the hell could any one open my safe from an airplane?" Leonard exploded. "He'd have to have long arms!"

"O. K.," Bill said. "Listen: The first plane that flew over your place had the robber in it. It flew low enough so that some one dropped over the side with a 'chute on his back. He landed on your property. The whole thing was perfectly planned. He knew just where every servant and every watchman and every one of your family would be at that time. It was an easy matter for him to slip into the house, go upstairs and surprise the watchman. He killed him before he could cry out a warning."

"Yeah," Clarkson sneered, "an' how did he get out? Jump back into the airplane?"

"No," Bill said. "He had the combination of your safe, Mr. Leonard. Where he learned that is another question. After he had cleaned it out, stowing the jewels in a little zipper bag, probably, he went up on your roof terrace. When he signaled with a flashlight, the same plane, an autogiro, immediately came down over your house. The autogiro dropped a ladder or a rope. He swung himself up on it and the autogiro went back where it came from."

All five of Bill's listeners, including Shorty, stared at him silently.

Then Clarkson said softly, "I think he's right. It's the only logical explanation. You're sure such a thing could be done, Barnes?"

"Get me an autogiro. Shorty and I will do it for you," Bill offered.

"I believe you, Barnes," Julian Leonard said. "You won't have to demonstrate. It's the first time I've ever heard of a burglary being committed from the air."

"It isn't the first time it has been done," Bill said. "I'd like to look at some of those footprints and see if I can find any resemblance to the footprints found outside the Barnabas place. I suppose you've had them photographed for comparison?"

"Yes," Clarkson said. "Get a couple of flashlights, Rhodes."

Bill studied the various footprints that had been blocked off by the police. One set in particular—which led from the center of a wide span of lawn toward the house. Once he stopped and picked up a small lump of red clay, which he stuck in a handkerchief after examining it. Then he asked Clarkson to take him to the room where the robbery and murder had been committed.

"Keep your eyes open for that trademark of the Black Hawk," Bill said to Shorty. Bill made a circle with his thumb and forefinger. "It'll be about that size."

There was nothing in Julian Leonard's study to indicate that a murder had taken place there, except the large dark stain on the plain blue rug. Bill went over the walls and baseboards for some sign of the stamp of the Black Hawk. Then he turned to the safe. There was nothing in it but a small strong box and a tan-colored memorandum book.

"Do you mind if I look through this book?" Bill asked Julian Leonard.

Leonard shook his head.

Bill leafed through it quickly and saw it was a record of Julian Leonard's transactions in the field of precious jewels. He was about to shove it back into the safe when he turned the last page.

There, inside the back cover, was the imprint of a black hawk. It was a duplicate of the one Bill had found above the Barnabas safe.

"The Black Hawk left his trademark again," Bill said. "It's the same man who did the Barnabas job."

"That's something, Barnes," Leonard said. "It's more than we've had before. I hope you're interested enough to go on and clear this thing up. It will be worth a lot to you."

"We'll talk about what it's worth later," Bill said. "But I will go on with it. I'm more than interested."

"What about that bit of red clay you picked up out in the yard?" Clarkson asked. "What are you going to do with that?"

"I wanted to ask you about that," Bill said, smiling. "I want to find out where that particular kind of clay occurs in the country. It certainly didn't come from any place in Florida. North or South Carolina perhaps. Where can we scare up a geologist? He ought to be able to put his finger on the spot. Get the idea?"

"Yeah," Clarkson said. "When you find that out what do you do?"

"While we're finding that out," Bill said, "we'll also check the autogiros in the country. We can check that through the bureau of air commerce. My men on Barnes Field will do that. There are very few licensed autogiros. If we can find the owner of an autogiro in the section that clay came from we'll be getting hot, or at least warm."

IV—SANDY FIGHTS ALONE

AT TEN O'CLOCK the same evening Bill Barnes and Shorty left for Miami, young Sandy Sanders stuck his tousled blond head into the traffic-control office on Barnes Field. He heard the roar of a Barnes Diesel overhead and saw the electric eye automatically switch on the shadowless, sodium-vapor light which was so perfectly diffused it would not blind the incoming pilot.

"Go ahead. . . . Go ahead!" Tony Lamport chanted into the microphone hung before his lips.

"Goat ahead! Goat ahead!" Sandy mimicked. "Who's that coming in, Tony?"

"Hello, pest," Tony said without looking around. "BBX answering. O. K., Bill, go ahead. Where are you? Go ahead! Go ahead!"

Sandy listened to Tony's conversation with Bill, his eyes wide. When Tony had finished he turned around and grinned at Sandy.

"That was Red coming in a minute ago," he said.

"That carrot-headed lout!" Sandy said. "Where's Bill?"

"Bill had a couple of telephone calls and hopped for Miami. I don't know just what it's all about. I was busy about the time he took off. But he just told me three fighting ships jumped him over North Carolina and gave me instructions to order all ships checked and ready to go. That included the Eaglet. You better get the dust off her."

"Dust!" Sandy shouted. "Say! She's always ready to go. Did Bill say who tried to shoot him down, or why?"

"No," Tony said. "Get out of here. I have work to do."

"You and your work." Sandy laughed. "I just came up to tell you I'm going to take a ship out. I have a little test I want to make."

"Test!" Tony shouted. "Do you know it's snowing and there is hardly any ceiling. Go tell that to Scotty. He'll tell you to test out your bed."

"I know he will," Sandy said. "That's why I didn't tell him. I thought it would be a good night to do what I wanted to because Bill said he was going to New York. If he's down in Florida, that's even better.

"Tony, I'm not going to take the Eaglet. I'm going to take a Snorter because I want to cut out over the Atlantic."

"Going to Paris?" Tony asked politely.

"Nuts!" Sandy said. "I picked this night on purpose. It's ideal for what I want to do. You know, I paid a lot of dough for three new carrier pigeons. I've been training 'em and I want to see what they can do. They're supposed to be good. I'm going out about a hundred miles, turn 'em loose and see if they get back all right. If they can do it on this kind of a night they can do it any time."

"Why don't you ship them up to that guy you've been working with in Canada and let him turn them loose?" Tony asked.

"Well," Sandy said, "you see, this is kind of a personal test. I want to see if I can turn 'em loose and get back before they do. I'm going to give 'em a handicap, of course."

"I haven't heard a word you've said," Tony replied. "You know what Bill or Scotty would say about your trying a thing like that. Don't tell me about it. Tell them. I'm not going to take the responsibility."

"O. K.," Sandy said, and disappeared down the stairs.

Ten minutes later he wandered into the hangar where the Snorters were kept and nodded to the half dozen mechanics and grease monkeys who were on duty. He was dressed in a fur-lined white leather overall, flying boots and a heavy helmet.

"Roll out a Snorter and warm her up," he snapped in his best imitation of Bill.

The mechanic in charge looked at him doubtfully as the grease monkeys grinned at one another. "There's a pretty low ceiling and it's snowing," he said.

"Bill got away all right," Sandy said. "That one of Shorty's there will do. He's with Bill."

Fifteen minutes later he stowed a small bag containing the pigeons in the gunner's cockpit and climbed into the forward one.

He took the ship into the storm with a verve and precision that would have done credit to Bill Barnes himself. At five thousand feet he leveled off and listened to the steady drone of the twin Diesels for a moment. Satisfied, he pulled out a map rack and plotted his course.

After five minutes of flying into the storm he checked his drift and took his position again. He noticed that the storm was abating.

In another twenty minutes he checked his air speed against his chronometer and took his bearings. They told him that he was a good hundred miles out. He flicked his radio switch and chanted Tony's call letters into the microphone. When Tony answered he asked him about the weather.

"Clear as a bell now, kid," Tony said. "And you better get back here before

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you get your head knocked off. Scotty knows you took a Snorter out, and he's raving around here like a madman. He says he's going to insist Bill ground you for six months." Tony chuckled. "How do you like those potatoes, kid?"

"Nuts!" Sandy said, but his heart wasn't in it. He was panicky. Suppose Bill did ground him for six months? "I'm going to let one pigeon go in a minute," he said. "It's too bad it stopped snowing and blowing. I've wasted my time."

"It's almost like daylight in here," Tony said. "Where are you? What's your position?"

Sandy figured for a minute and gave it to him.

"You better shake a leg, kid," Tony said. "I'm signing off."

Sandy dived a hand into the rear cockpit of the Snorter and brought up the bag containing the three pigeons. He made sure the little metal tag was fastened securely on the leg of each carrier, then let one of them go.

"What," he asked himself, "is the use in taking a chance on losing more than one of them? If they get back it won't prove anything, because the storm has stopped." The moon was riding high now, in all its cold glory. Its reflection drew a jagged line across the surface of the dancing Atlantic and glistened on the tail of the Snorter.

He brought the Snorter around in a swift climbing turn and stuck the nose on an invisible Barnes Field. He wondered if there was any way he could keep old Scotty from telling Bill about his flight.

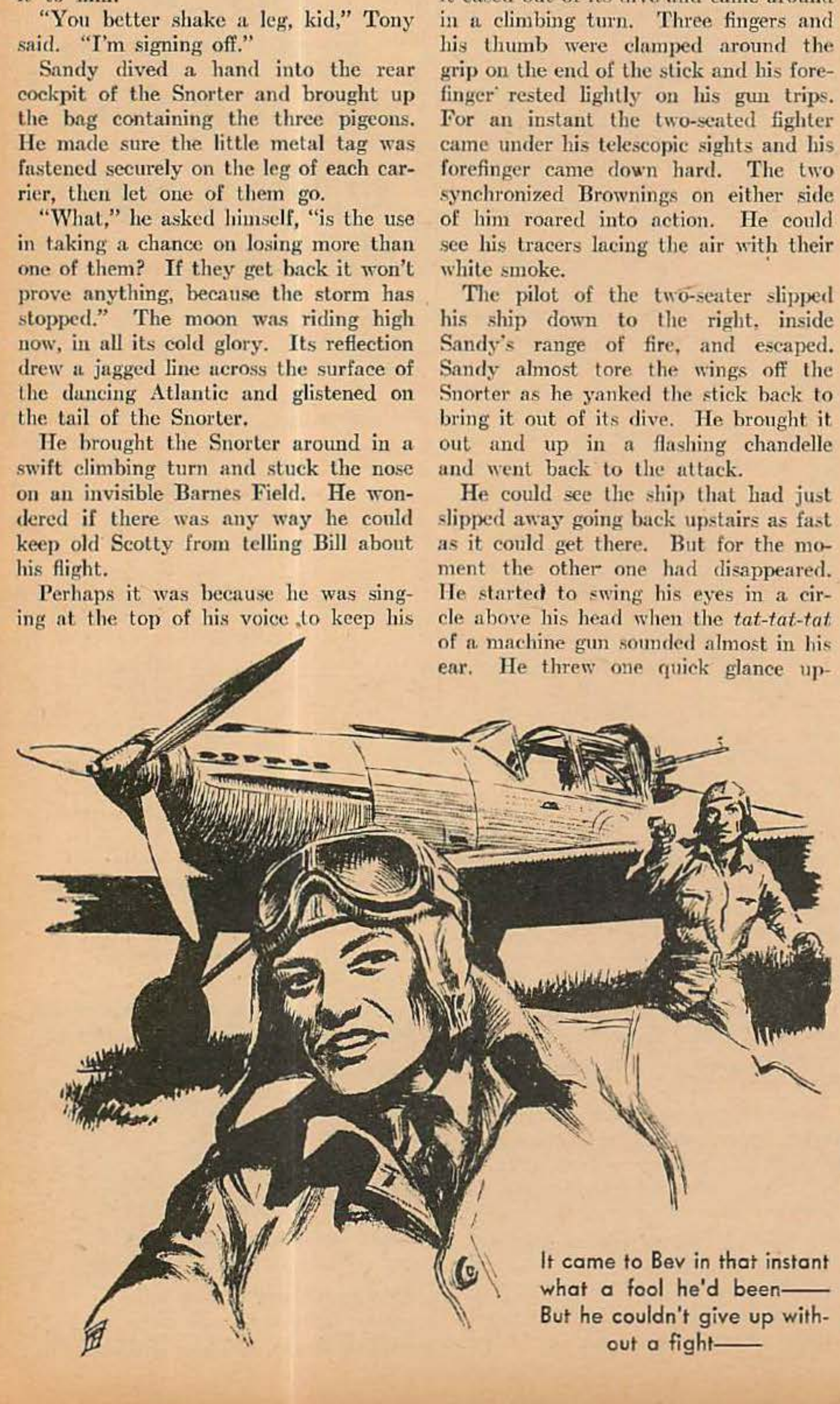
Perhaps it was because he was singing at the top of his voice to keep his engines company that he didn't hear the scream of those two diving props until they were on his tail and were lacing machine-gun bullets through his wings. Perhaps it was carelessness.

The two plunging ships on his tail went underneath him as he brought the Snorter over on its back and rolled right side up. For an instant he hesitated. Should he turn tail and make a break for Barnes Field? He reached for his radio switch to tell Tony Lamport to send Red Gleason, Cy Hawkins and Mort Henderson out to meet him.

Then his pride got the better of him. He stuck the nose of the Snorter down and dived at one of the two-seaters as it eased out of its dive and came around in a climbing turn. Three fingers and his thumb were clamped around the grip on the end of the stick and his forefinger rested lightly on his gun trips. For an instant the two-seated fighter came under his telescopic sights and his forefinger came down hard. The two synchronized Brownings on either side of him roared into action. He could see his tracers lacing the air with their white smoke.

The pilot of the two-seater slipped his ship down to the right, inside Sandy's range of fire, and escaped. Sandy almost tore the wings off the Snorter as he yanked the stick back to bring it out of its dive. He brought it out and up in a flashing chandelle and went back to the attack.

He could see the ship that had just slipped away going back upstairs as fast as it could get there. But for the moment the other one had disappeared. He started to swing his eyes in a circle above his head when the *tat-tat-tat* of a machine gun sounded almost in his ear. He threw one quick glance upward and backward as his hand tightened around the stick convulsively.



It came to Bev in that instant what a fool he'd been—— But he couldn't give up without a fight——

The two-seater was diving on him from above again. He could see his tracers and he could feel the impact as a sheet of death drove through his Snorter. For an instant his heart stopped beating. The man had him so that he had no chance to survive. He could feel that stream of lead creeping along the tail as he kicked his rudder and threw his stick to bring his ship up and around in a fast climbing turn. As his engines almost stalled he stuck the nose down and leveled off.

A moment later Sandy saw that he had made a terrible tactical mistake. The ship that dived below him had come out of its dive as Sandy began his climbing turn. It came up and around with him and was riding just below his tail. The other one was riding just above him. He tried desperately to outmaneuver them and get into the clear, where he could use his guns. But they were too smart for him, and they were forcing him lower and lower as they fired burst after burst of fire through his tail.

Suddenly one of them dived straight across his sights to lure him lower. As Sandy dived on him the other one came down on his tail and forced him even lower. He knew the game they were playing, but he couldn't do anything about it. The ships they were flying were as fast as his Snorter, they knew every trick known to fighting airmen, and they knew how to shoot.

Then he realized why they were pouring round after round into his tail and purposely missing him. They were trying to force him down without injuring him. He realized it when his stick was almost useless and his rudder entirely gone. He pushed himself up out of his bucket seat and saw that the rudder had been shot away from its post. More than that, one of the control cables to his flippers had been shot away.

He eased the nose of his Snorter down and put it into a long glide. The choppy waves of the Great South Bay seemed to be reaching for him. He lifted the tail as best he could when he was almost down and a hundred yards from the beach. His forward momentum slapped the pontoons of the Snorter down on the water until it seemed they would be broken into matchwood.

Sandy was reaching for his radio switch to make contact with Tony Lamport as the big ship raced toward the beach. As Tony spoke into his ear phones Sandy cut him off.

"I've been shot down, Tony!" he said. "I——" And that was all. The Snorter tried to climb out of the water and onto the beach like some huge monster of a million years ago.

There was a horrible wrenching sound

and a thud as Sandy went out of his seat and crashed into the windshield. The big ship teetered up and went over on its nose with its props still whirling. They dug in and died.

Sandy's body slumped down over the instrument panel and slid to the floor. Blood trickled down from underneath his helmet as the two-seated fighters skimmed the sands of the hard-packed beach for a landing.

V—KIDNAPING AND MURDER

BILL BARNES was possessed of that peculiar faculty of being able to come fully awake at any hour on which he decided before he went to sleep.

The room was shrouded in darkness, except for a thin stream of moonlight that cut across the bottom of the sill of the window. There wasn't a single sound or the faintest rustle to disturb the quiet of the night except the noises that came from the streets.

Yet something, some inherent instinct, warned him not to move, not to even raise his arm to look at the luminous dial of his wrist watch. The muscles of his body became tense. He could feel perspiration oozing out of his body. He knew that something was in the room.

Suddenly a thin stream of light struck the couch from his left and danced across the room until it shone directly on his stomach. A lean, bronzed hand came between the stream of light and his vision—a hand that clasped a knife. The blade was only two inches from his heart.

Cold sweat ran into his eyes as he conquered an almost overwhelming desire to shout or throw his body out from underneath that knife. He knew that when he moved he must move with the speed of lightning or the knife would come to rest between his ribs. He thought of the two watchmen who had been guarding the Barnabas and Leonard jewels, who had been killed instantly with a knife.

Slowly, without moving the rest of his body, he brought his right leg up. He knew that only a couple of seconds had passed since that light and that knife had appeared, but it had seemed like an eternity. He knew that any moment it might come swooping down to rip him open.

Like a streak of lightning he whirled his body away to the right and at the same instant brought his right foot over the bed. It crashed against something that grunted at the contact and went hurtling back into the darkness. At the same time he slid off the side of the bed to the floor.

For thirty long, horrible seconds he stayed as still as death itself while he tried to pick up the breathing of the other man in the room. His nerves were taut and screaming as he reached as far over his head as he could and gently tapped the floor. Something whistled through the air and vibrated back and forth where it had stuck into the wall above his head.

He cursed himself for not having stuck a gun under his pillow.

As the whir of the knife ceased, the room was absolutely still again. He listened for the faintest sound, the scrape of a button or the exhaling of breath. When he could stand it no longer he began to ease his body under the bed. He knew there was a bedside table and a lamp on the other side. He edged forward an inch at a time, breathing quietly through his mouth. He heard a creak, then saw a shaft of light cut across the room as the door to the hallway opened and a breeze fanned his hot face.

He scrambled out from under the bed, pausing to snap on the bedside light. The room was empty and the door was still ajar. He crossed the room in one jump and ran into the hall. It, too, was empty—only silence in the long corridor. He whirled back into the room and grabbed for the telephone just as the bell pealed.

"I have a long-distance call for you, Mr. Barnes," the operator said as he made noises in the mouthpiece.

"Wait a minute!" Bill shouted. "Hold it! Some one was in my room. They just went out the door and disappeared down the corridor. Tell the house detectives. Do you get that?"

"Yes," the operator gasped. "Do you want to take the call?"

"Put 'em on," Bill said. "Where's it from?"

"Long Island."

"Make it fast," Bill snapped.

"Just a minute, please," the operator said.

"Hello, Bill," Tony Lamport said.

"O. K., Tony," Bill said. "Shoot it! What's happened?"

"It's Sandy, Bill," Tony said.

"All right!" Bill shouted. "What's the matter?"

"He came in my office last night," Tony said, "and told me he was going to take a Snorter out over the Atlantic and release three of his new carrier pigeons. I told him he was crazy and to get permission from Scotty. He wouldn't listen to me. So I told him I hadn't heard him and refused to take any responsibility."

"What happened?" Bill said more quietly. He was getting hold of himself now.

"An hour after he left, the storm had cleared inshore and he reported it was clearing over the Atlantic. He gave me his position about a hundred miles out and said he was coming back. I told him Scotty knew he had taken a Snorter and was raising hell. He said he would be right in."

"What happened?" Bill shouted again.

"I didn't hear anything from him for about twenty minutes. Then I caught his call signal. I tried to speak to him, but he cut in on me. 'I've been shot down, Tony,' he said. 'I——' And that was all. I heard a terrific crash. Then I couldn't get him again. I—— You getting this, Bill?"

"Then what?" Bill snapped. "Come on, man. Talk!"

"I kept on trying while I got Scotty out of bed. But I couldn't get an answer. Red and Cy and Mort Henderson had their Snorters in the air within twenty minutes. I gave them Sandy's last position and the last report he gave me. They're out looking for him. But it isn't daylight yet. I——"

"The damned little fool," Bill grated.

"Wait a minute, Bill," Tony said. "A couple of minutes ago one of Sandy's carrier pigeons came in with a note fastened to its leg. It wasn't the one Sandy had released over the Atlantic. It came in quite a time ago. This one had a note signed by the Black Hawk. That's the signature: a picture of a black hawk."

"And?" Bill snarled.

"You'd better come back and read it, Bill," Tony said.

Bill sucked in his breath and exhaled it again like a whale rising to blow. "They haven't killed him, have they, Tony?" he asked softly.

"No," Tony said. "They say he was pretty badly smashed up. They've taken him prisoner and are going to hold him as a hostage until you drop the Black Hawk thing. Scotty says he doesn't know just what you're working on and no one else here knows. We don't know what to do. They say they'll cut Sandy's throat if you don't lay off, Bill. What shall we do?"

"Listen!" Bill said. "Don't make me repeat. I've got to speak fast and move fast. Keep Red and Cy and Henderson out searching. Get Martin and Scotty into the air, too. Tell them to keep circling. He should have been near the tip of Long Island when he last talked to you, if it was twenty minutes after he gave his position. Check that position. They ought to be able to locate the Snorter, or some wreckage from it.

"And get that information about the autogiros I wanted last night. You couldn't find anything in my files?"

"Nothing," Tony said. "We're all nearly nuts up here, Bill. What are you going to do?"

"I'm coming up there," Bill said. "I've got to get Shorty out of bed and get out to Dinner Key to get the Lancer. I'll be there in three hours."

"You're not going to stop in North Carolina?" Tony asked.

"To hell with North Carolina!" Bill

said, and slapped the receiver on the hook. He stood with his fist pressed against his mouth for a matter of ten seconds. Then he grabbed the telephone again.

"Hello, operator," he said, "get me the chief of police, Mr. Clarkson. While you're getting him, give me Mr. Hassfurther's room. . . . Right."

"Hello, Bill," Shorty said. "Is it six o'clock?"

"It's five thirty," Bill snapped. "We're leaving here in five minutes for Dinner Key. Some one who signs himself the Black Hawk has snatched Sandy, fella. I'll see you downstairs in five minutes. Get some coffee if you have time."

He pulled down the hook and then jiggled it.

"Here's Mr. Clarkson, Mr. Barnes," the operator said.

"Hello, Bar——" Clarkson began.

"I've got to get back to my field fast," Bill broke in. "Can you give me a police car and an escort that can get me out to my plane in fifteen minutes?"

"Yes," Clarkson said. "How soon do you want it?"

"Five minutes, in front of the hotel. Good-by," Bill said.

He tore off the pajamas he was wearing and was in his clothes and fur-lined overall and boots in exactly one minute and a half. He heard a police siren screaming in front of the hotel as he stepped out of the elevator. Shorty was paying their bill at the cashier's desk. He had a thermos bottle of coffee in one hand and his bag in the other.

The house detective came puffing up to Bill. "We haven't been able to locate any strange person on the premises, Mr. Barnes," he said. "If you'll come into the manager's office we'd like to question you about the man you saw in your room. You're sure you didn't imagine it, sir?"

"Listen," Bill said, "by the time you get awake I'll be in New York. If you think I imagined it, go up to my room and take a look at the knife sticking into the wall. Come on, fella," he said to Shorty.

Clarkson was getting out of his car in front of the hotel when Bill and Shorty went down the steps. Bill didn't wait for him to ask questions. He told him what had happened in his room in twenty-five words.

"We may need that knife for evidence," Bill said. "Keep it and get the fingerprints."

"But, Barnes——"

"You'll hear from me," Bill said. He pushed Shorty into the car, stepped in behind him and said "Let's go!" to the chauffeur. A motor cycle swung out from the curb in front of them with its siren screaming. They sped over the Miami River bridge at sixty miles an hour. The police chauffeur began to brake the big car as it flashed by the hangars of the coast guard. He took the entrance to the International Airways on two wheels and came to a halt before the first enormous hangar.

The Silver Lancer gleamed on the turntable at the water's edge. Bill thanked the police chauffeur, grabbed his bag and ran toward it. He went up the steps and into the front cockpit with Shorty on his heels.

"She's O. K., Mr. Barnes," a uniformed official said to him.

"Thanks," Bill said. "Send me a bill."

The grease monkeys, mechanics and other employees at Dinner Key are still talking about that take-off. Bill took the Lancer down the bay and into the air with a speed that left them gasping. Before they had time to comment to one another about it the Silver Lancer had become a part of the false dawn.

"Give me a slug of that coffee," Bill said to Shorty. He nursed the throttles of the Lancer as he checked his bearings and laid a course that would take them to Barnes Field in the shortest possible time.

"Here you are," Shorty said. He passed a steaming metal cup of the coffee forward. "Do you know anything more than you told me about Sandy?"

"No." Bill told Shorty what Tony had told him. "This lad who calls himself the Black Hawk must have learned our wave length and heard Sandy talking to Tony when Sandy gave his position," he finished.

"Then he must be some place not far from Barnes Field," Shorty said.

"Yeah?" Bill said. "I thought a half hour ago he was in my room in the Tropical Hotel." He told Shorty about the hand and the knife that had been poised over his heart.

It was less than three hours from the time he talked to Tony Lamport on the telephone that the Silver Lancer circled Barnes Field, cut down into the wind and swooped in for a landing. Bill and Shorty were both out on the apron as the big ship rolled to a stop. Red Gleason came tearing down the steps of the administration building.

"What do you know, fella?" Bill asked him. His voice was harsh and his eyes were red spots in his face.

"Not much, Bill," he said. "We found the kid's ship. It was all smashed to hell on the beach not far from Patchogue. He must have landed on the water and stuck the nose up on the beach. It had a couple of hundred bullet holes in it. The wings and tail were peppered."

"What about the cockpit?"

"There were a couple that might have gone through the gunner's cockpit," Red said. "But the pilot's cockpit was clear. They forced him down by shooting away his rudder and controls."

"They wanted him alive," Bill said slowly.

"There was a lot of blood in the forward cockpit," Red said.

"Where's that note?" Bill asked.

"Scotty has it," Red said. "Here he comes."

Old Scotty MacCloskey's long, gaunt face was even more dour-looking than usual. He knew that Sandy was like a young brother to Bill, and he held himself partly responsible for Sandy's plight. He gripped Bill's hand and said, "I'm sorry, boy."

"It's not your fault, Scotty," Bill said. "I'm going to ground that kid if"—he corrected himself—"when he gets back. Where's that note?"

"It's in your office, Bill," Scotty said. "In the top right-hand drawer of your desk."

"Right," Bill snapped. He started toward the administration building, then whirled. "Dig up Cy and Henderson," he said. "I want to see all of you in my office."

Bill smoothed out the penciled note on his desk. His stomach turned over as he thought of the horrible kidnapings and murders that had occurred in the past few years.

The note read:

> BILL BARNES, OR HIS MEN:
>
> Sanders was stunned from his crack-up, but was not badly injured. We have been waiting for a chance to grab him. He will not be hurt if you and all of your men keep your nose out of our business. You will not be warned again. The Black Hawk is going to do one more job. It will be his last and must be successful. When it is over Sanders will be released unharmed. If you interfere we'll slit his throat.

The letter was signed with the imprint of a black hawk.

"They've been listening in on our radio conversation for weeks, probably," Bill said to Shorty.

Shorty nodded and saw that Bill's sunken eyes were burning with that unquenchable flame that would not admit defeat.

"They have planned this thing for some time. They knew I wouldn't be here last night and knew that I might never come back. They used the Leonard thing to draw a red herring across the trail and get me out of the way. The Barnabas and Leonard robberies tie together in some manner."

"What's the next move?" Shorty asked.

"Things are beginning to dovetail in my mind," Bill said. "I'll tell you when Cy and Henderson get here."

VI—ORDERS

BILL looked over the little group of intent faces assembled in his office, and something very close to a lump gathered in his throat. The only face that was missing was Sandy's. Beverly Bates, one of Bill's younger pilots, had just come in from California. He listened carefully while Bill explained the things that had happened. He cursed softly as he heard of the capture of Sandy.

"We'll find him, old fella," he said to Bill in his clipped Boston accent. His face was grim as he took his place with the rest of Bill's men.

"All right," Bill said. "I'll only take your time for a minute. We're all through with words now. It's time for action. This man who calls himself the Black Hawk has come to us and asked for it. I think Sandy is comparatively safe at the moment. On the other hand, they may keep their word and slit his throat if the occasion demands it.

"I don't want the police or the Federal men to know anything about this. We'll handle it in our own way. I'm as much in the dark as you are, except I have a couple of hunches. They were caused by little things that occurred and wouldn't make sense if I tried to tell you about them.

"We have two jobs on our hands at the moment. One of them is to recover the Leonard jewels. But that is secondary. First we want to get Sandy. I've mapped out a little plan. It, too, may sound senseless to you. When we try it we'll know whether or not we're getting results.

"Shorty, I want you to take a Snorter and hop to the vicinity of Old Orchard Beach, Maine. When you get there, nose around all the airports within a hundred miles and see if you can pick up any trace of planes that answer the description of the two-place monoplanes that attacked us the other night.

"I want you to keep in touch with Tony all the time—not on our old wave length, but on the new one Tony will give you before you leave. Tony, you'll have to dig up an unassigned wave length that we can use for a day or two without the Federal communications commission knowing about it. If any trouble arises from that I'll have to fix it.

"I can't tell you much about the three ships that attacked us the other night except that they were low-winged monoplanes with, I think, 1100 h.p. Meredith power plants in the nose. They were finished in a gray or green, I think, and they mounted synchronized machine guns and could carry two or three twenty-five-pound bombs in a rack under the belly. That's all I know about them. But that's enough if they've landed any place, because of the machine guns.

"Red, I want you to get out to Michigan as fast as you can. Be sure of your fuel. It's cold out there where you're going, and desolate. I want you to cruise out of Detroit above the fishing country. There are plenty of lakes there. Watch for activity around a fishing camp. You'll be able to spot it when you see it because most of that country is frozen up at this time of year.

"The same thing goes for you, Cy. You get down to Florida and check on all the airports in the State. The big ones, I mean. I want you to keep your eyes open for an autogiro that can't be accounted for on the night of the Leonard robbery. That goes for you, too, Henderson. I want you to cover the air above eastern North Carolina—around Raleigh. There is one autogiro in Raleigh. Find out where it was the night of that robbery. Locate the place that clay came from if you can.

"Bev, you scout around the end of Long Island, New York, and the Connecticut shore. You may be in the hottest territory, because those ships that picked up Sandy last night got to him within twenty minutes from the time he gave Tony his position. That doesn't mean they are still around. The idea is to find out where they came from.

"I want you to keep in touch with us all the time. I'll be here waiting for your reports to come in. I may be able to tell from them just where we ought to concentrate our efforts. It will be tough going because we have so much territory to cover.

"You all know what I want to know. I have reasons for sending you to these particular places. If you see or hear anything suspicious in any of those localities we may find Sandy there—and the Black Hawk."

"Do you have the analysis of that clay, Bill?" Mort Henderson asked.

Bill nodded his head. "Anything else?" he asked.

They got to their feet silently. Their faces were grim with determination. They knew what was expected of them and Bill knew they would die trying to accomplish it.

"All right," Bill said. "Good luck, and keep your noses out of the ground. We—we've got to find that kid!"

VII—CAPTURED

SHORTY HASSFURTHER flipped a hand into the air as Tony Lamport flashed an "all-clear" signal from the traffic-control room. He blasted his Snorter around as he poured juice into his twin Diesels and took the ship down a cleared runway with characteristic skill. The tail lifted, and Shorty took the Snorter to three thousand feet in tight spirals.

He glanced at his ammunition counters and checked his powerful .50-caliber guns to be sure they weren't jammed. Then he stuck the nose of the Snorter on a course that would take him along

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WHEELS per pr.
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½ .01 .03
¾ .02 .04 .05
1 .03 .05 .07
1¼ .04 .08 .10
1¾ .07 .10 .16
3 .15 .30

PINE WHLS., pr.
Both sides alike
¾" 4c; 1" 6c
1⅜" 8c; 1¾" 12c

NOSE BLOCKS
1x2x1 ....1c
2x2x1 ....2c
2x2½x1 .....3c
3x3x1 ....5c
3x3x2 ....8c
3x3x3 ......10c

INSIGNIA
24 and stripes 5c

WASHERS
1 doz. ⅛ or ¼ 1c

THRUST BEARINGS
Small, ..doz. 10c
Large, ..doz. 15c

RUBBER
.045 ...25 ft. 5c
1/16 sq., 20 ft. 5c
⅛ flat ..18 ft. 5c
3/16 flat 12 ft. 5c
Skein 50c

PROPELLER BLOCKS
½x ¾x 5 8—5c
½x ¾x 6 6—5c
⅝x1 x 7 4—5c
⅝x1 x 8 3—5c
¾x1¼x10 2—5c
¾x1¼x12 3c ea.
1 x1½x12 4c ea.
1 x1½x15 6c ea.

SHEET ALUM.
.0003x3½..ft. 1c
.005 in. 6x6 5c
.010 in. 6x6 6c

CLEAR DOPE
5c per oz.; Large bottle, 8c; ½ pt. 30c; 1 pt. 45c

THINNER
Same as clear dope

COLORED DOPE
5c per oz.; Large bottle, 8c; ½ pt. 35c; pt. 60c

CLEAR CEMENT
5c per oz.; Large bottle, 8c; ½ pt. 35c; 1 pt. 55c

MACHINE-CUT BALSA PROPS
5" 4c; 6" 5c;
7" 6c; 8" 7c;
10" 8c; 12" 10c
15" 15c

BAMBOO
1/16 sq.x12, 36, 5c
1/16x¼x15, dz. 10c

DOWELS
1/16x6 ..doz. 5c
⅛x18 ..2 for 5c
3/16x¼ .2 for 5c

WIRE
6-8-10-12-14 ....2 ft. 1c

WOOD VENEER PAPER
20x30 ..1 for 10c

BAMBOO PAPER 2 for 15c

CELLULOID
6x8 ....5c
12½x16 ....18c

WING AND TAIL LIGHTS
12" 10c; 15" 15c; 24" 20c.

REED
1/32-1/16-⅛. ....2 for 1c

CAMEL'S HAIR BRUSHES
Small 3c; Lge. 5c
Extra large...8c

NOSE PLUGS
½" ..... doz. 8c

DUMMY RAD. ENGINE (Celu.)
1½" d. 15c; 2" d. 20c; 3" d. 25c.

ENGINE AND COWL (Celu.)
1½" dia. 15c
2" dia. 20c
3" dia. 25c

CELLULOID PANTS, per pair
½" to 1" ..18c
1⅛" to 1¾" .33c

METAL PROPELLERS
2 blades 3 blades
1½"..5c ... .08
2½".10c ... .10
3½".15c ... .20
4½".20c ... .25

ALUM. TUBING
1/16, 3/32, ⅛ ....ft. 7c
3/16 or ¼ ft. 10c

ALUM. COWLINGS
1½" 15c 2" 18c 3" 25c
Specify whether anti-drag or closed

BOMBS
¾"..4c 1¼"..7c 3"..12c

GUNS WITH RING MOUNT
1¼" 10c 1¾" 15c

PURSUIT MACH. GUNS
¾", 1¼" or 1¾", each 5c

BUSHINGS
1/16 ...4 for 1c

WOND. WATER SPRAYER 15c

MODEL PINS
½" or 1" pkg. 5c

SANDPAPER
Doz. sheets...5c

PROP. SHAFTS, REAR HOOKS
doz. 8c

MODEL STANDS
Sm. 15c; lge. 25c

RUBBER LUBRICANT, lge. bot. 10c

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the shore of the Great South Bay and out over the tip of Long Island. East of Patchogue he sighted his own twisted Snorter and circled low above it five times. It was only too evident what had happened to Sandy.

"He probably took a brutal slap on his noggin when she nosed over," he said to himself. He stayed down close to the water as the Hamptons and Montauk State Park flashed under his wings. He circled Block Island and Martha's Vineyard and roared above Provincetown, on the tip of Cape Cod, only five hundred feet in the air.

When he left Cape Cod he made contact with Tony Lamport and told him he was laying a course for Gloucester that would take him from twenty to thirty miles off the coast of Massachusetts.

"Play it safe, guy," Tony said.

"I'm a cautious man," Shorty said, and laughed at Tony's short answer.

Halfway between Provincetown and Gloucester he saw a plane about a mile in front of him. It was flying at an altitude of only a hundred feet above the open water.

Suddenly he stiffened in his seat as two Very lights puffed out from the low-flying plane. His first instinct was to get down and answer the distress signal, but something about the situation aroused his suspicions.

As he nosed down he saw that the ship was a two-place, low-winged monoplane. It was finished in a dull, battleship gray. Shorty circled downward while he studied the plane. It certainly fitted the description Bill had given them. Yet it obviously seemed to be in distress. At times one wing dipped until it was almost dragging in the water, then recovered and staggered drunkenly. He could not hear the motor above the roar of his own Diesels.

If they were in trouble, Shorty knew he must make a landing and stand by until he could summon help, or take them ashore in the after cockpit of his Snorter. He could see the pilot and another man in the rear cockpit. The man in the rear cockpit was standing and waving his arms at him. He was nearly thrown over the side as the plane lurched badly and crabbed off to the right.

But Shorty was suspicious. He circled low above the plane and studied it. If it were one of the Black Hawk's ships they might be trying to decoy him into a trap. But how would they know that he was taking an open-water course between Provincetown and Gloucester? His report to Tony, of course. That was the way they had picked up Sandy. They had probably picked up the new wave length.

The man at the controls of the staggering ship turned a white face upward and waved a frantic arm in Shorty's direction. Shorty nosed down cautiously, knowing he would be able to pull the two occupants of the ship out of the water if it plunged those last few feet. He was about to put his pontoons down on the rolling surface when it happened.

How he ever escaped that hail of lead from above he didn't know. He didn't hear the roar of the power plant in the diving monoplane until machine-gun bullets began to thud into his tail assembly. He threw one frightened glance up over his shoulder and opened the throttles of the Snorter wide. At the same time he kicked his rudder until it slapped against the stop and dipped his right wing.

The bullets that vomited from the two guns in the nose of the diving ship came almost up to the cockpit before they danced off to the left and drummed into his left wing as he came around. His instantaneous coördination was all that saved him from being torn to a bloody pulp.

Perspiration cascaded down his face as he yanked the stick back into his stomach and took his Snorter upstairs. The ship in distress had become very much alive. It was climbing frantically, trying to get above him. The diving monoplane had pulled out of its dive and was zooming upward at terrific speed.

Shorty, watching them, knew that the men at the controls of the two gray ships were no novices. They knew how to get everything out of their planes.

The terrific momentum of the diving monoplane had taken it up fast as it zoomed. It was a thousand feet above Shorty as it came to an approximate stall, dropped its nose and dived again. Its screaming bullets chewed through the trailing edge of Shorty's left wing as the other ship raced at him with terrific speed.

Shorty coolly yanked the stick back into his stomach and hung his Snorter on its two props. As he came to the top of his loop he half rolled it upright and opened his throttles wide.

The ship that had been on his tail stuck its nose up and chandelled back to get on Shorty's tail again. Shorty stuck his own nose up in a climbing turn, came over on one wing and opened his throttles. The two ships roared toward each other like two mad bulls. Shorty's finger clamped down on his electric gun trip. His guns yammered out their stream of death. He saw them wipe out a section of the windshield of the other ship and knew that the ship had side-slipped out of range.

The three planes raced and tumbled all over the wintry skies, while the Atlantic licked its lips and waited for them. They asked for no quarter and gave none. It wasn't a gallant fight in which one wasted bullets and waved good-by to another. They fought viciously, with no one offering an opening for a kill. And they conserved their ammunition.

Then the air would be filled with flaming lead for a brief instant. Shorty matched his uncanny skill against the two of them. He was fighting with the same desperate skill that had saved his life a thousand times. The thought of peeling off and running had never occurred to him. They had been waiting for him, had laid a trap to murder him. That alone gave extra skill to his touch as he whipped his Snorter through the air. But he knew this couldn't go on forever. He must get them or they would get him. His teeth were tightly clenched, his breath coming in short, sharp gasps. He maneuvered one of the gray ships into an error while he ignored the other one.

And that instant, while he had it under his hair sights, was enough. His finger clamped down and he saw his bullets drawing a line from the tail to the nose of the gray ship. He saw the pilot half rise from his seat and sink back. He saw the nose of the enemy ship drop and knew it was plunging to its death. His eyes were glittering as he probed the air all about him for some sign of the other ship. He located it in a moment. It was five thousand feet above him and headed in a direction that would take it to Europe!

He threw his radio key and chanted Tony Lamport's call letters into his microphone as his engines began to stutter. He switched to another tank and they blasted forth their full-throated roar again. But he knew that one, and perhaps more than one, of his tanks had been punctured.

When Tony answered him he gave a brief account of the fight. "I can't follow the one who peeled off," he finished. "There is something wrong with one of my tanks. Ask Bill for orders."

"Hold it," Tony said, "he's right here." He came back on the phone a moment later. "Bill says to get into Boston and have your ship checked. Keep in contact."

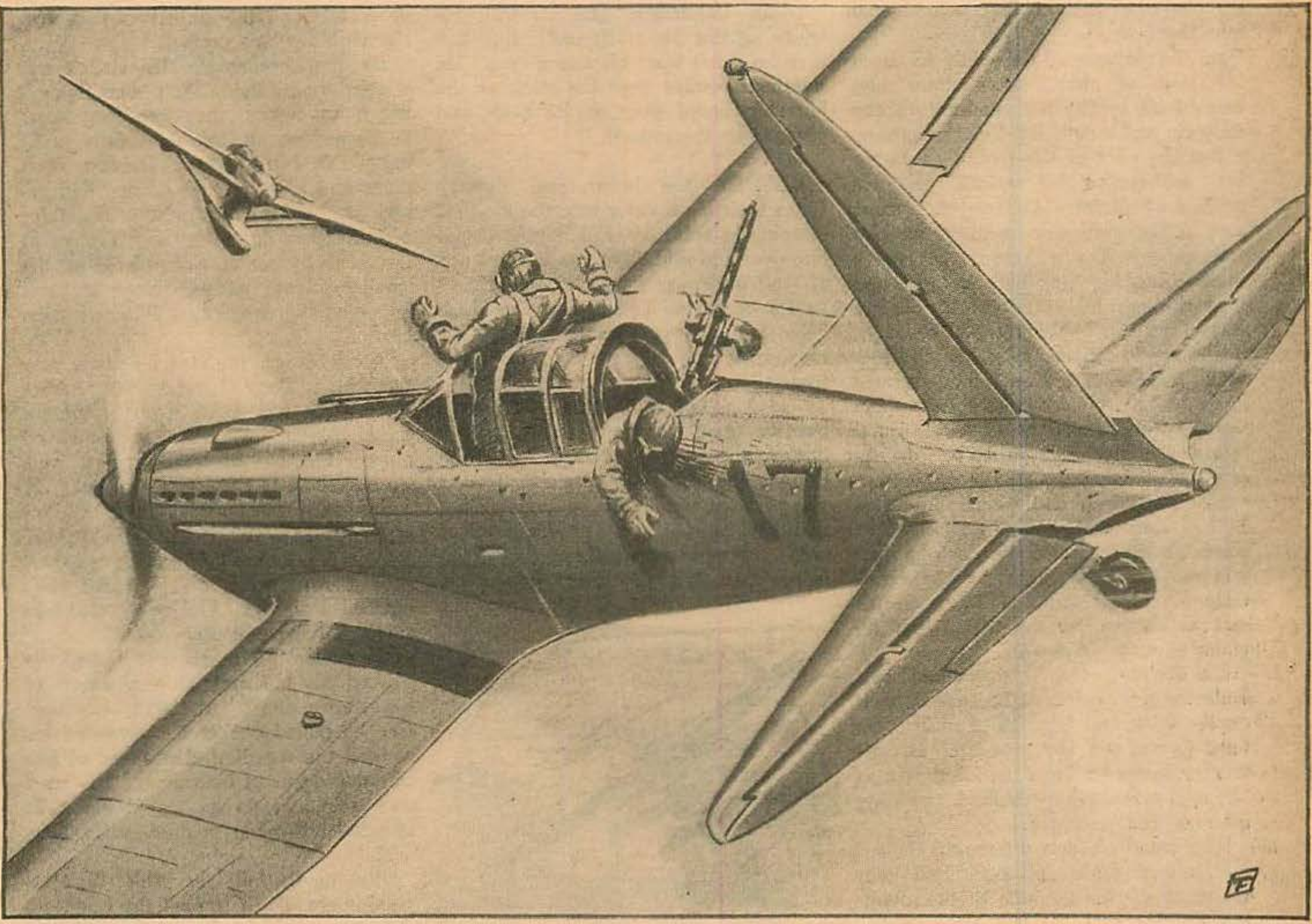
"O. K.," Shorty said.

"Wait a minute," said Tony. "Bill wants to know if there is a chance of picking up the pilot or gunner of the ship you shot down."

"I looked for them," Shorty said. "They plunged with their ship."

"O. K.," Tony said. "Signing off."

AT ALMOST the same moment Shorty Hassfurther left the tip of Cape Cod behind him, Mort Henderson, the two-hundred-and-twenty-pound flying engineer from California, slapped the stick of his Snorter forward and glided from Cape Charles across Hampton Roads to the Virginia Shore. He had ten thousand feet under him when he



That one instant, while he had the gray ship under his hair sights, was enough—— He saw the pilot half rise from his seat—sink back——

sped above the city of Norfolk and stuck the nose of his Snorter on Raleigh, North Carolina.

He was above the Dismal Swamp—that marshy, uninhabitable stretch of water and land in both Virginia and North Carolina—when three low-winged monoplanes finished in battleship gray came diving out of a wisp of fleecy clouds a thousand feet overhead, their engines roaring. He cursed himself for his carelessness as white streams of tracers floated through the air and bullets thudded into his ship. His large, good-humored mouth became a hard, firm line across his face as he yanked his control column back and came up in a loop. At the top he centered his controls and rolled right side up.

For an instant he was out of danger, but only for an instant. The three ships came out of their dive and attacked him from three different directions. He gunned his Snorter and pulled away from them. Then he whipped up and back in a flashing chandelle and went head-on into them as they reversed their directions. His finger was fastened down hard on his gun trips. He raked the gray ship in the lead with a withering fire. The pilot's head disappeared from above the cowling and the ship slipped off to the right, almost colliding with another gray ship.

"That," Henderson said aloud, "would be Number 1."

Then the two remaining gray monoplanes seemed to become a dozen ships. Besides the two fixed guns operated by the pilots of the gray planes there were gunners with flexible machine guns in the after cockpits. For a moment it seemed to Henderson the world was populated with nothing but men with machine guns.

But he knew that if he could escape their first mad attack the superior performance and maneuverability of his Snorter would begin to tell. He tried desperately to stay on the tails of the two monoplanes because he was protected from their gunners' bullets by his engines and the gunners were open targets.

He pounced on one of them with his guns yammering. He saw the gunner's tracers creeping along his right wing and saw that he was overshooting. He eased his stick forward and clamped down on the trips again. The gunner's body shot straight up and over the cowling as Henderson's powerful .50-caliber bullets drove into him. The pilot skidded his ship to the right and pulled the nose up out of danger.

A thousand thoughts flashed through Henderson's mind as he tried to shake off the other two-seater. He knew his Snorter was taking a terrific pounding from the enemies' machine guns and that they would destroy it if he didn't knock another of the gray ships out of the air.

Through his mind, almost unconsciously, flashed all of the things Bill Barnes had taught him about fighting a single-seater plane against a two-seater.

He knew that he must keep above the two gray ships as much as possible and keep away from them. In-fighting would mean his destruction. He knew that he must get the second gunner by the same direct-dive method he had got the first one. Or he must approach from under a wing tip, or the tail.

He brought his Snorter up and over in a flashing Immelmann as the two ships tried to converge on him. As they reversed their directions he came around in another Immelmann and dived under the tail of one of the gray ships at terrific speed. Then he turned the nose up for one brief instant and poured lead into the belly.

As the ship yawed off wildly he eased the nose of the Snorter down and banked off to the left, underneath the wing tip and out of sight of the gunner.

But the pilot of the second gray ship had anticipated his attack and his method of retreat. As Henderson came around the gray ship pounced on him from above like a hungry cat on a mouse. Machine-gun bullets ripped and tore through his tail assembly before he could throw his Snorter out of range. Something smashed into his shoulder with a force that threw him forward against his rubber crash pad. The whole world seemed to explode around him as his Snorter began to reel drunkenly.

He pushed himself back into his bucket seat and dimly realized that when he was thrown forward he had jammed the stick hard to the right. Only his safety strap held him in his seat as his Snorter did things that no plane is supposed to do.

His dazed eyes saw his turn-and-bank indicator going mad as he tugged back on the stick and tried to neutralize his controls and get the nose up. His altimeter showed a bare thousand feet as he felt machine-gun bullets thudding into his Snorter again.

The sound of their drumming cleared his stunned brain and infuriated him. He glanced over the side of his plunging Snorter and realized that in another few seconds the two heavy engines in the nose would be driven back into his lap. He unsnapped his safety clasp and tried to push himself up and out of his seat. But the ship was whirling too fast now. He was held in the cockpit by centrifugal force. His heart climbed up into his mouth as the doomed ship spun closer and closer to the ground.

He lashed out with his feet as he tried to plunge out of the gyrating ship. His foot caught against the control column and he used it as a lever to push himself up on the cowling. The ground was racing at him now at terrific speed. He bellowed and cursed as he kicked backward again against the stick.

What happened, or why, no one will ever know. But the force of his savage kicks against the stick exerted some magic upon the controls. The nose of the Snorter rose as it came out of its mad spin.

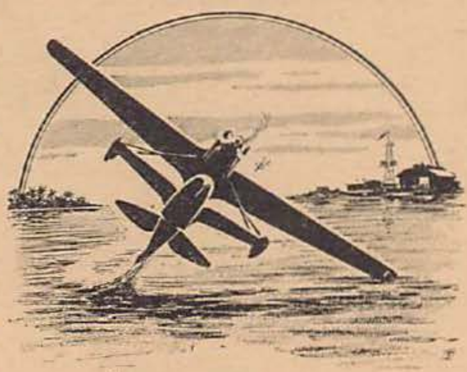
With a half-mad cry, Henderson threw himself back into his bucket seat. He leveled the Snorter off and tried to give it the gun. But the nose began to fall again. He took one quick glance over the side and yanked back on the stick. But the ship would not respond. There was a horrible, sickening crash as the two great props knifed into the top of a pine tree.

Again Henderson was thrown violently against his crash pad. But this time he didn't open his dazed eyes. He slumped forward over the stick as the big ship nosed over on its back and plunged to the ground.

BEFORE the brown-eyed Beverly Bates took his Snorter into the air that morning in February, Bill Barnes looked him over and said, "Do you have plenty of stuff underneath your overall, Bev?"

"It's a heated suit, Bill," Bev said. "You told me you wanted me to get way upstairs. It'll be cold up there to-day."

"Good fella," Bill said. "It's cold, but it's clear. I want you to get up in the gallery, where you can see everything. The visibility is perfect. I want you to keep circling above Long Island and the Sound and the Connecticut shore. If you see anything that looks like a two-place, low-wing monoplane, finished in gray, stay above it until it lands. Find out where it goes. It will lead you to Sandy, I think."



The grease monkeys, mechanics and other employees at Dinner Key are still talking about that take-off.

"O. K., Bill," Bev said. "I'll get up where they can't see me."

"Keep in the sun if you sight anything," Bill said.

Bev took his ship off in a long, low climb and kept spiraling upward until he had thirty thousand feet under him. He had his overhead hatch battened down so that it was air-tight, and his oxygen jet was open. The temperature outside his cockpit was sixty-five degrees below zero, but his electrically heated overalls, helmet, gloves, and boots kept him warm.

From his vantage point of almost six miles in the air he could see in any direction for over a hundred and fifty miles. He was in the substratosphere and above the "dust" sphere because of weather conditions.

Where the earth and the sky merged in the distance there was only a band of white haze. Above that band the sky was a pale blue, and higher up it deepened in color until it seemed almost black. But directly below him the visibility was perfect.

He kept widening the circle over which he was flying, and then tightening it up again. For two long hours he droned on and on, constantly probing the air beneath him. He saw transports and private ships coming and going. A half dozen times he dived his own Snorter down, keeping always in the sun, to get a closer look at the smaller private planes. None of them answered the description Bill had given him.

Every fifteen minutes he made contact with Tony Lamport on Barnes Field. He was making his report for the eighth time when his eyes wandered out to the end of his starboard wing tip and scanned the air below him.

Suddenly he sat upright in his bucket seat. "Listen, Tony!" he said. "I think I see a two-seated fighter. She's a low-winged monoplane, and I think she's finished in gray. I'm going to make sure. I'll make contact later."

He circled around so that he had the sun on his tail and stuck the nose of his Snorter down. At twenty thousand feet he pulled out of his dive and examined the speeding ship ahead of him through a pair of binoculars. His heart was pounding as he threw his radio switch and made contact with Tony again.

"I'm on its tail!" he said. "It's beginning a glide in toward the Connecticut shore. I'll stay with it and pick you up later."

Bev's eyes were burning as he saw the gray ship glide in for a landing on what looked to be a small private air field. At one end of the field was a hangar large enough to accommodate a half dozen small planes such as the one that had just landed.

He saw two men climb out of the gray ship and wave a hand at a man standing inside the hangar. Then they disappeared into the foliage that surrounded the field.

Circling lower and lower, Bev saw that there was only one man on the field. Bev decided to do a thing he would not have done if he had taken more time to consider. He glanced at the wind sock atop the hangar. He took his Snorter in for a landing, fishtailing to reduce his speed. He brought the big ship to a halt a few feet away from the gray monoplane, locked his wheel brakes and idled his motors so they were just turning over. Then he hopped over the side of the Snorter. He hadn't taken a half dozen steps when a man with a gun in his hand popped up inside the gray monoplane.

"Get your hands high in the air!" the man said to Bev.

It came to Bev in that instant what a fool he had been. His face drained of all color—not from fright, but from anger at himself for walking into such a trap—as he automatically started to put up his hands. He knew what Bill would say to him for walking into a place from which there was no way to retreat. He had thought that by leaving his engines idling he could get in the cockpit of his Snorter and get it away if any one appeared unexpectedly. The unforeseen had happened.

He raised his hands above his head. At the same time he decided that he wouldn't be taken without a fight. As the man lowered his gun for an instant to drop over the side of the gray ship, Bev swung on his toes and sprinted for the Snorter.

He had taken just six steps when he heard the gun behind him roar. At the same instant something knocked him forward on his face and the world became a black void.

VIII—THE CREW SETS FORTH

BILL BARNES paced nervously back and forth in the traffic-control room, listening to the reports of his men as they came in to Tony Lamport. He picked up a pair of ear phones and clamped them to his ears as Tony said "Red" over his shoulder.

"Tell Bill it's quiet as a graveyard out here," Red said. "I dropped in on the boys at Detroit and they didn't know a thing. I circled that particular lake Bill told me about a half dozen times. There isn't a sign of life anywhere around it. All the cabins are boarded up tight. Not a puff of smoke. Ask him what he wants me to do."

"Tell him to report back here!" Bill snapped at Tony.

When Tony had closed his contact with Red he told him to try to get Mort Henderson and Bev Bates again. Tony began his chant into the microphone, but there was no answer to his call.

"He's got both of 'em," Bill snarled. "Try Shorty. Tell him to get back here fast if his tanks are patched up."

Tony nodded his head. He watched Bill anxiously as he saw that his face was taut and strained.

"It proves one thing," Bill said, biting off his words. "The danger spots are around here and in North Carolina. Why North Carolina? Keep on trying to pick up Bev and Henderson. It isn't like Bev to be caught napping. They must have caught him asleep. He——"

"*Bill! Quick!*" Tony said. "On the window sill there. That pigeon. It's one of Sandy's!"

Bill was across the room in two strides. He slid up the window a half inch at a time while his nerves screamed for action. He made the noises he thought he ought to make to get the pigeon's confidence. But when he put out a hand to grasp it, it soared off the window ledge and into the air. He could see the piece of paper that was rolled into a cylinder and tied around the pigeon's leg. He groaned as the pigeon soared upward.

"Wait!" Tony whispered at his side. "It will come back. Sandy sends them out from here, and they always come back here. Let me get it." He darted across the room, dug a hand into a large paper bag and ran back to the window to sprinkle grain along the ledge. "It will come back," he repeated.

"It's got to come back!" Bill whispered, and his face was white with emotion. He stood still, hardly breathing, while Tony made cooing noises at the bird.

"Come to baby," Tony whispered, and made kissing sounds with his lips. The pigeon circled near the window, alighted on the ledge. Tony left his hand still for what seemed all eternity to Bill. Then he slid it forward and got the bird by one foot. It fluttered for a moment, trying to escape, then remained still. Tony slipped it into the crook of his arm while Bill closed the window. He cut the little cylinder of paper away from the pigeon's leg and unrolled it with trembling fingers.

He stared with puzzled eyes at the single sentence written on it in Sandy's handwriting. It was so hastily scrawled that it was almost illegible, yet he knew that Sandy had written it.

It read:

GOLD TRAIN THIS AFTERNOON

That was all.

"What does it mean?" Tony asked him.

"I don't know," Bill said. He sat down in a chair and stared at the piece of paper. He turned it over and looked at the back and seemed surprised that there was nothing written on it. Then he went carefully over the events of the past twenty-four hours.

Suddenly, as the thought of that piece of North Carolina clay he had picked up on the lawn of the Leonard estate flashed through his mind, he came out of his chair as though he had been sitting on a red-hot spike.

"Quick!" he said. "Get me Scotty!"

Tony plugged into the administration building, the repair shop, and finally Scotty's quarters before he found him.

Bill grabbed a telephone and shouted into the mouthpiece. "You've got to work fast, Scotty," he said, biting off his words. "I want the carrier-transport and the Lancer out on the apron ready to go in fifteen minutes! You'll have to pilot the transport. Be sure of her cannon and machine-gun ammunition. Load her belly full of bombs. Check the Lancer's ammunition and fuel. Take young Gordon to relieve you at the controls. We'll need you on the cannon. Put Martin in the nose; old Charlie in the tail; McCoy and Neely in the wing cockpits; Miles on the retractable gun pit, and some one—young Carlyle, will do—to fly Sandy's Eaglet. Have you got it?"

"Yes, boy," old Scotty said. "Where are we going?"

"I don't know," Bill answered. "We'll pick up Cy and Red and Shorty over the army field at Dayton, Ohio. I'll take you where we're going."

He slapped the receiver on its hook and pointed a finger at the round-eyed Tony Lamport.

"Contact Cy—he'll be near Charleston, South Carolina—and tell him to pick me up over the Dayton Airport at three o'clock. The same goes for Red and Shorty. Keep trying to get Henderson and Bev. If you get through to them, tell them the same thing. Remember, not on the airport, over it."

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¼x¼ ....6 for 5c
½x¼ ....3 for 5c
½x½ ....3 for 5c

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1x2, 1 for............ 9c
2x2, 1 for............15c
2x3, 1 for............19c
2x6, 1 for............35c

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6x8 .... 4c
12x16 ......15c
Clear Dope
1 oz. 5c
½ pt. 25c
Colored Dope
1 oz. 5c
½ pt. 30c

Clear Cement
1 oz. 5c
½ pt........25c
1 pt.........45c
Wood Veneer
20x30", 1 for. 9c
2 for 17c
Reed
1/32, 1/16" ....3 ft. 1c
⅛" .....3 for 2c

Wooden Wheels
½", 2 pair ..3c
¾", pair ..2c
1", pair ..4c
1⅜", pair ..4c
1¾", pair ..7c
Celluloid Wheels
¾", pair .. 5c
1", pair .. 7c
1⅜", pair .. 9c
1⅞", pair ..15c
Balsa Balloon Wheels
½" ..1 pr. 2c
¾" ....pr. 3c
1" ....pr. 4c
1⅜" ....pr. 5c
2" ....pr. 8c
3" ....pr. 14c
PROP. SHAFTS, 2 for 1c
PAUL-O-WINA JAP PROPS
5" 10c
(add 5c per inch for props up to 10".)

Machine Props
5" 4c
(add 1c per in. for props up to 16".)
Rubber Motors
1/16 sq. 20 ft. 5c
⅛ flat .20 ft. 5c
INSIGNIAS—French, American, English, German
1¼"..4 for 3c
2" 1c
1 sheet of 24, 5c
Dummy Radial Engines
1½" Diam....14c
2" Diam.....18c
3" Diam.....23c
DOWELS, 1/6x12. 10c per doz.
SPOT WELDED HOLLOW ALUMINUM WHEELS
1" .....pr. 6c
1⅜".....pr. 11c
1⅞".....pr. 14c

Sheet Aluminum
.003..sq. ft. 10c
Alum. Tubing
1/16", 3/16", ¼" ....10c ft.
ALUM. LEAF, 2 sheets for 1c
WIRE, 6 ft. 3c
36" lengths.
NOSE PLUGS,
large..10c doz.
small..5c doz.
Miscellaneous
Washers, ¼ ⅛ doz. 1c
Sandpaper, pkg. 5c
Model Pins, pkg. 5c
Brushes No. 6..5c
Thrust Bearings ...1c
Bushings, doz. 3c

ORDERS 75c or under 15c postage. Postage prepaid on orders over 75c. West of Mississippi add 10c extra.
Canada: add 15c extra on orders under $1.00. On orders over $1.00 add 15%.
CASH OR MONEY ORDER—NO STAMPS—NO C. O. D.'s.

SKYWAY MODEL AIRCRAFT SUPPLY CO.
383 Seventh Ave.,
Dept. B
Brooklyn, N. Y.

Bill picked out the ship clearly through his infra-red-ray telescope. The air churned with flame——

"Where shall I say you've gone, Bill?" Tony asked.

But there was no one listening. Bill was halfway down the stairs.

Barnes Field had suddenly become a place of feverish activity. Scotty MacCloskey and Martin, the master mechanic, were working their men at top speed, checking over the gigantic carrier-transport and Bill's Lancer. A dozen mechanics and grease monkeys were swarming over the sleek-looking monster.

Her sixteen-foot props became shimmering disks as Scotty blasted the two fifteen-hundred h.p. supercharged Diesels. Above and behind Scotty's head, on a circular platform, young Gordon was inspecting the rapid-firing one-pounder.

In the midships section, Carlyle, a black-haired kid with Irish-blue eyes, was going over Sandy's fast little fighter, the Eaglet. Suspended by its landing hook from an overhead girder, the Eaglet was locked rigidly in place on the girders, and hung with its cockpit just above the level of the deck. Behind the Eaglet's hangar, Miles was greasing the mechanism of a retractable machine-gun turret.

Behind the dining saloon, living quarters and lavatories, old Charlie, the cook and tail machine gunner, was checking the supplies in the galley.

Up in the glass-inclosed nose Martin was inspecting the .50-caliber machine gun and the bomb sights and releases. In the two cockpits abaft the engines, McCoy and Neely were breaking down their guns and inspecting them with the fond delight of two mothers administering to their young.

The big ship was ready to go when Bill had finished warming up the Lancer. "You're in command of the carrier, Scotty," Bill shouted above the roar of four engines. "Get fifteen thousand under you. I'll be a couple of thousand above you. I'll lead the way. Are you ready to go?"

Scotty flicked a switch on his instrument panel and checked his crew over the intercockpit telephone.

"We're ready to go, boy," Scotty said solemnly.

"Let her ride!" Bill roared.

The big transport rolled down the concrete with ponderous grace. Scotty bounced it off the runway and took it upward in wide, sweeping spirals.

The three thousand horses in the nose of the Lancer blasted forth like a symphony heavy with brass. Bill kicked the ship around into the wind and streaked down the runway with the speed of a silver bullet. The sesquiplane gear rose smoothly to disappear into the belly and wings. He took the ship to seventeen thousand feet and made contact with Scotty on the radio.

"Jack her up to three fifty," he said. "And tell your crew to keep their eyes open. Some one may drop in to call on 'em and they'll bring machine-gun bullets instead of calling cards!"

"O. K., Bill," Scotty said, and his voice was eager. "It's nice to be going back to the wars again."

"You may wish you were back on the field with your knitting!" Bill growled.

IX—VICTORY

Bill laid a course that took him high above the industrial towns of New Jersey and the Pocono Mountains.

Above Harrisburg, Pennsylvania, he spoke to Scotty again. "We'll follow a course along the Pennsylvania Railroad," he said. "Everything O. K.?"

"O. K.," Scotty answered.

They left the Allegheny Mountains behind as they sped above the famous Horseshoe Bend beyond Altoona. At Pittsburgh, where the Allegheny and Monongahela Rivers formed a junction, they saw the first sign of the horrible floods that were forming in the valley of the Ohio River.

"A perfect set-up for the old pirate," Bill growled to himself. Then added, "If I'm right!"

Wheeling, West Virginia, and then Columbus, Ohio, flashed under their wings. As they neared Dayton, Bill began to chant Shorty's call letters into his microphone.

"Shorty answering, Bill," came to his ears in a moment. "I'm almost on your tail. I spotted you at Columbus."

"Right, fella," Bill said. "Your Snorter is all right?"

"Riding like a summer breeze," Shorty said.

"Ammunition?" Bill asked.

"O. K."

"I'm going to try to get Cy and Red now," Bill said.

Two minutes later they both checked in. They were circling above the army field at Dayton.

"Right," Bill said. "Are you all listening in?"

They checked in one after another.

"Scotty," Bill said, "you'd better let young Carlyle take the Eaglet out of the transport now. We're going to need him, I think. Red, you and Shorty take a position on each side of the transport when Carlyle gets the Eaglet away. Cy, you get under the tail, young Carlyle just above it. I'm going to stay a couple of thousand feet above and in front of you.

"We cut due south at Dayton until we are above the Ohio River. Then we cut west until we strike the L. & M. out of Cincinnati. After we strike the L. & M. I'm going to step on ahead. You follow the railroad, Scotty."

"What are we doing, playing hare and hounds, Bill?" Shorty asked.

"No!" Bill said sharply. "Maybe I'm a sucker. I don't know yet. I've just added up a lot of things and it's possible I don't have the right answer. If I'm right, you want to keep your powder dry, because you'll be needing it."

Twenty minutes later the great swollen mass of water that was the Ohio River appeared beneath them. It was far over its banks, flooding cities and villages. Ten minutes after that Bill said into his microphone, "There's the L. & M. dead ahead. Keep your radio switches open. If I tell you to step it up, I'll mean just that."

He opened his throttles and poured soup into his engines as he took the Lancer to fifteen thousand feet. Far ahead of him he saw the Kentucky River winding its way through the lowlands to join the Ohio. He took a pair of binoculars from a flap pocket and swept the sky in all directions.

Then, as he thundered closer and closer to that spot where the L. & M. crossed the Kentucky River he saw what he had been looking for and he knew a savage joy.

He had not seen the two-place, low-winged monoplanes he had been seeking because they were far below him. He counted them as they broke their formation and began to circle at a thousand feet. There were three flights of six planes each.

As Bill sped high above them he came around in a vertical bank so that he could see them more *plainly*. Suddenly his heart stood still. The eighteen planes were circling above two trains that had stopped just before the first one plunged into the Kentucky River. The railroad bridge was gone!

"I thought so!" Bill said softly. He stuck the nose of the Lancer down as thirty-six men went over the sides of those eighteen ships with parachutes strapped to their backs.

The 'chutes floated out behind them. Then thirty-six balls of cotton began their descent to earth. The eighteen gray monoplanes started in eighteen different directions as they heard that screaming comet that was the Lancer coming out of the sky.

At two thousand feet, Bill yanked back on the stick of the Lancer until it seemed the thing would collapse like a ring of smoke caught by a breeze. But the nose came up, and Bill saw that all thirty-six of those men floating to earth carried machine guns with them.

Then he saw six of the eighteen planes form a V. At a flip of the tail of the leader the six ships dived until they were only three hundred feet above the second of the two stalled trains. As they sped over the train they each dropped three twenty-five-pound bombs on the top of it. Wood, steel, dirt, stones and smoke belched out of the ground. The six gray monoplanes zoomed upward, to be followed by six more in formation.

The remaining six formed an arrowhead column and stuck their noses toward Bill as he yanked the control column of the Lancer back again and took it upstairs. He laughed as he did it. But it wasn't a laugh of merriment. It was a result of that same savage joy that had made him glad he had arrived in time. His voice was a snarl when he spoke into his microphone.

"Pour in the soup!" he roared at his men. "I found what I was looking for. Shorty, the Black Hawk's gang of bandits have blown out the L. & M. railroad bridge over the Kentucky River. A gold train carrying over a hundred million dollars to the new government gold depository near Frankfort is stalled this side of the bridge.

"Eighteen of those gray monoplanes just dropped thirty-six men with machine guns over their sides. They're bombing the train to blow it open to get to the gold. The train is guarded, but they're murdering the guards. Pour in the soup! I'm coming back to join you!"

"Aren't you going to stop them, boy?" Scotty asked.

"That's just what we're going to do," Bill snarled. "I'm signing off now to get Tony. I want to tell him to get James Morton in Washington and have the army send a squadron here after we get through mopping up. They'll never get here in time to save that train crew and guard, nor the gold."

Three minutes later Bill whipped around on one wing and took a position above the transport. The eighteen gray monoplanes had formed three flights of six planes each and had climbed a thousand feet above Bill and his men when they attacked.

"You'll have to protect yourselves, Scotty!" Bill screamed as they dived. "They can't get close to you if your men use their guns right!"

Then they were on them, their guns spewing fire and lead and death. Bill's men broke their formation and shot out of that terrific concentration of fire when the eighteen diving ships were only four hundred yards away. They zoomed and rolled and came up and over in flashing Immelmanns to escape.

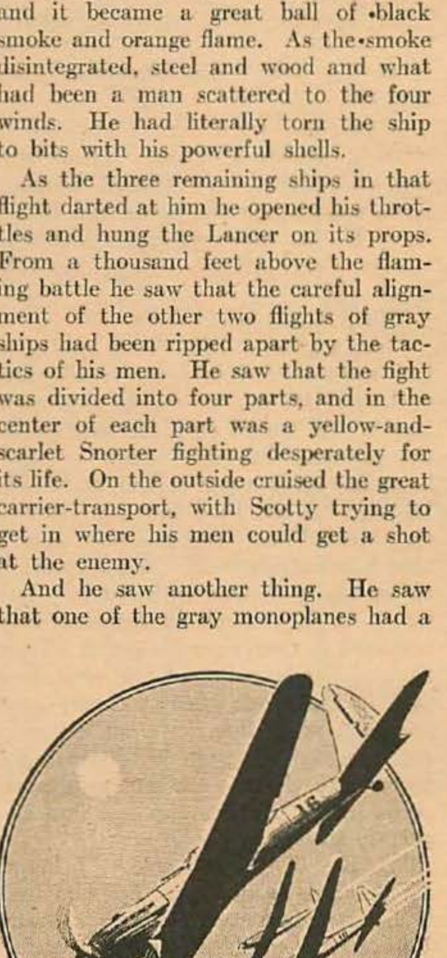
Bill waited until the six ships that were diving on him were only two hundred yards away. He could feel bullets hammering into the metal wings of the Lancer and knew that she was being raked with a fearful amount of lead.

Then he got one of the gray ships under his sights and his fingers clamped down on his gun trip. He fired just eight shots at that first one and saw the pilot slump over his stick. He corrected his aim and another speeding gray streak came under his eye. He saw his bullets drive into the engine housing and saw flame shoot out of the oil-gushing hole and lick back.

He yanked back on his stick to zoom above the other four ships and came over on his back. He eased his control column forward and roared down in an inverted dive. He shifted his forefinger to the trip of his 37mm cannon as a gray ship banked over on one wing to turn. His shells ripped into the climbing nose of the two-place fighter and it became a great ball of black smoke and orange flame. As the smoke disintegrated, steel and wood and what had been a man scattered to the four winds. He had literally torn the ship to bits with his powerful shells.

As the three remaining ships in that flight darted at him he opened his throttles and hung the Lancer on its props. From a thousand feet above the flaming battle he saw that the careful alignment of the other two flights of gray ships had been ripped apart by the tactics of his men. He saw that the fight was divided into four parts, and in the center of each part was a yellow-and-scarlet Snorter fighting desperately for its life. On the outside cruised the great carrier-transport, with Scotty trying to get in where his men could get a shot at the enemy.

And he saw another thing. He saw that one of the gray monoplanes had a special marking on the side of it. The pilot was staying on the outer rim of the battle, darting in now and again when he thought he saw an opening.



"That," Bill snarled, "would be the leader of the squadron."

He brought the Lancer around in a flashing chandelle and stuck the nose down. His finger clamped down on his gun trip when he was three hundred yards away from that ship with the special markings. But the gray monoplane had seen Bill make his dive, and the pilot skillfully slipped his ship out of range of Bill's screaming bullets. Bill leveled off and chandelled back to the attack.

The monoplane came up and rolled level at the top of his loop and gunned his engine. The two ships roared at one another at terrific speed. Bill's face was a mask of concentrated fury as he tried to get the ship inside his hair sights. His finger clamped down again and his tracers told him that his bullets were tearing into the right wing of the monoplane and creeping toward the pilot's cockpit. But as they chewed along the side of the fuselage again, the pilot threw his ship out of range.

"You can't do that forever," Bill gritted through clenched teeth. "No murderer can live forever."

The two ships streaked and tumbled through the sky, their chattering guns flaming, their props screaming defiance. The leader of the gray ships was slipping away from Bill's deadly attacks with an ability that was uncanny.

Then Bill saw the man laughing as they swept by one another at terrific speed. For an instant he could not believe his eyes. He nearly lost control of himself. The man was laughing at him!

His body began to drip with perspiration. He gripped the control column of the Lancer with a hand that was like a band of steel. He brought the Lancer up and over in a loop and rolled it level at the top as the enemy ship whipped back with a wing-over.

Again they roared at one another. Bill got the gray ship under his sights, then eased the control column and his right rudder. As the gray ship started to slip out of range he slipped into it. The shells from Bill's 37mm cannon made a shambles of what had been a plane and a man. They disappeared in a ball of orange flame as the gray plane's fuel tanks exploded.

Probing the air around him, Bill saw that the rest of the battle had drifted off to the right. He and the leader of those gray monoplanes had been fighting a lone battle. He saw a gray ship zoom up and then begin to flutter to earth as he raced back to aid his men.

He went into that mass of snarling, raging ships like a charging rhinoceros. He tore through the ranks of the enemy ships, swerving neither to the right nor to the left, his guns belching death.

As three of the gray ships whirled to pounce on him he flipped over like a hawk and dived on their flank. His finger came down on his trip as he caught one of them under his sights. His burst of fire lasted only a part of a second. But it was enough. The pilot shot up in his seat like a jack-in-the-box and was thrown clear as the ship nosed down into a spin.

Bill saw Sandy's Eaglet, piloted by the capable hand of young Carlyle, following a gray ship as it pulled up steeply, rolled out of a loop at the top and dived back with its guns chattering. He wanted to shout a word of warning to Carlyle. But the words would have been wasted. He brought his Snorter up and over on its back as bullets drummed into his tail. At the top of his loop he neutralized his controls and opened his throttle. Hanging head downward, Carlyle lined up the gray ship in his hair sights and tripped his guns. Fire and smoke belched from the monoplane's engine housing as Carlyle tore by it. The pilot dived over the side as flames licked back into his face.

Off to the right, Shorty was the center of a delirious whirlpool of flaming death. Three gray ships were trying to get him in the vortex of their fire. Bill whipped away from the attack of two ships and went to Shorty's aid. He pounded one of the gray ships into débris with his cannon as Shorty poured lead and death into another one.

At the same instant, Cy Hawkins's yellow Snorter flashed over in a dazzling inverted loop to throw a plane off his tail, and came up under the tail of a gray monoplane. The monoplane staggered drunkenly as Cy tripped his guns, pouring lead into it. Then its nose fell away as Cy ripped its fuselage to ribbons with a furious fusillade. As it started its last plunge to earth to dig its own grave, the wings folded back like the wings of a diving duck.

Red Gleason followed another of the two-place monoplanes toward the ground while he ripped out its entrails with his guns. And as was his custom in the thick of battle, he was singing at the top of his voice.

That was enough for the little bevy of gray planes that were left. Bill and his men had sent eleven of them crashing to their death. The seven that remained peeled off with only one thought in mind: escape. They were not the same planes Bill had sighted only fifteen minutes before. There was no semblance of order about their flight. They dived out of the thick of battle in seven different directions. Their throttles were wide open as they poured juice into their screaming engines. Their white faces were strained and unreal as they glanced back.

"All right!" Bill roared into his microphone. "Let 'em go! We don't want 'em. Get back over those trains and clean out those machine gunners that are laying siege to them. Dive low and attack!"

The four Snorters came up and back to form a wide, ragged V behind Bill. But there were no machine gunners laying siege to the gold trains now. They had been driven off by the fury of the defense of the guards stationed inside the trains. The crews and the guards of the trains waved their arms at Bill and his men as they roared overhead.

"Look off to the north, Bill!" Shorty shouted into his microphone.

Bill and his men looked. They saw not one squadron of army planes, but three. Flying low was a squadron of eighteen attack planes. Above them bellowed a squadron of twelve bombers. High in the sky was a squadron of eighteen pursuit ships.

"The marines have landed," Red Gleason said, "and have the situation well in hand!"

"Calling all planes. . . . Calling all planes," Bill chanted into his microphone. "Proceed back to Barnes Field," Bill ordered. "I——"

"Bill!" Tony Lamport's voice cut in. "Tony speaking, Bill. . . . Tony speaking."

"O. K., Tony," Bill snapped. "Go ahead!"

"I just had word from a hospital in Raleigh, North Carolina. Henderson was shot down over Dismal Swamp. Some natives saw the battle and found him. He has a wound in his shoulder, and is badly bruised. They say he'll be O. K."

"Right," Bill said. "We——"

"Just a minute, Bill," Tony said. "I had word from Bev a couple of minutes ago. He got me on our old wave length. He landed on a private field in Connecticut. It was a trap, he said. Some one stuck a gun at him, and when he tried to get back into his Snorter they creased him. Just a surface wound that knocked him cold. When he came to he was in a room with Sandy. The kid is O. K., except for bruises. Bev managed to overpower his guard. Then he and Sandy captured the man Bev says is the Black Hawk. Sandy covered him while Bev made contact with me. He says some one will have to get there soon. He has one gun with seven shells in it. He says we can find the private airport by——"

"O. K., Tony!" Bill said. "I know! I'll be there in an hour. Tell him that if he makes contact with you again. I'm on my way! All planes proceed back to Barnes Field."

X—THE CAPTURE

BILL circled twice above the large, rambling house before he cut down into the wind and took the Lancer in beside Bev's Snorter. He killed his engines, locked his brakes and stepped out on the deserted air field.

He took a path that he believed would take him from the field to the rambling house. It was half hidden in the foliage, and when he came to the narrow gate it was entirely hidden. But the gate was open. He had been wondering how Bev had got from the big house to his Snorter and back again without being burned to a cinder.

Bev Bates opened the front door of the big house. His head was swathed in bandages. Bill shook his hand and said, "I should have given you better instructions, Bev. I'm sorry. I wasn't entirely sure about things."

Young Sandy was holding a gun on old Caleb Barnabas when Bill went into the room. His sunken eyes were glaring with all their old defiance. He was still the "swashbuckling old pirate" Bill's father had told him about.

"You're smart, Bill," old Barnabas said. "You'll get places."

"So will you," Bill said. "But you won't like it. You'll rot in prison."

"I'm not there yet, son," he answered. "How did you do it, Bill?"

"It wasn't hard," Bill said, "when I began to put things together. I'd only seen you a couple of times in my life before the night of your fake robbery here. You'd never bothered to get in touch with the son of your old friend before you got this diabolical idea."

"You'd have wanted money like every one else," the old man said.

"You knew the job you were contemplating was right down my alley," Bill said. "So you pulled the first trick with me present to allay suspicion. But when I began to check later I remembered you had told me about the private airport on your land. And I remembered the utter callousness with which you looked at the dead body of one of your old employees. It wasn't human.

"Then, you couldn't help getting even with your old rival Leonard before you pulled your big job. It was a duplicate of the robbery here. You thought you would allay my suspicions again when you suggested that Leonard get in touch with me. Leonard told me about your hatred for him. I was pretty sure then.

"But I was not certain. When you grabbed Sandy I remembered I had told you I regarded him with the same affection I might have for a son, if I had one. You thought you could get to me that way. You almost did.

"I sent my men out over the country because I knew you had a fishing lodge in Michigan and a home in Florida. But you weren't working from either of those places. You were working from here and from some place in North Carolina. A piece of red clay I picked up on Leonard's lawn led me to North

Carolina. Your men followed Henderson and shot him down. You might like to know he's going to live."

The old man didn't say anything.

"Where is your base down here?" Bill snapped.

"Near Raleigh," Barnabas said.

"Then I got a note from Sandy. His last carrier pigeon brought it to me." Bill laughed. "How did you get hold of that pigeon, kid?" he asked Sandy.

"He gave me a note to send to you," Sandy said, pointing to Barnabas. "I ate the one he gave me and switched the one you got."

"Like every one else," Bill went on, "I'd been reading about the gold trains taking gold from the mints at New York, Philadelphia, and Denver to the new fortress in Kentucky. I knew that was what you had up your sleeve. You were going to use the same tactics you used in those two robberies—dropping men in parachutes. I suppose there were trucks near by to pick up the gold?"

Barnabas nodded.

"And you figured the floods would help you, too," Bill said. "I wasn't sure, but I took a chance. I knew a gold train was scheduled to leave Philadelphia last night. I got there just in time. You have about fifty murders against you, Barnabas."

"You stopped 'em, eh?" Barnabas asked.

"We stopped 'em," Bill said. "What in hell did you want all that gold for?"

"The government took all my gold away from me," Barnabas snarled. "I dug my fortune out of the ground in the form of copper and turned it into gold. The fools in Washington are gathering all the gold men have dug out of the ground all over the world. What are they going to do with it?" Barnabas snorted and answered his own question. "They're going to put it back in the ground down in Kentucky. Does that make sense, you fool?"

Bill lifted his eyes as a telephone bell pealed in a corner of the room. Bev Bates lifted the receiver and spoke into the mouthpiece.

"Yeah, Tony," he said. "They're what——"

He grinned at Bill and Sandy as he listened. "We'll be back before long," he said to Tony, and hung up the receiver.

"Tony says the papers are out with special editions," Bev said. "The whole country knows about it. Congress is voting a special appropriation for you. You're in the headlines again, Bill."

"So is Barnabas," Bill said bitterly.

"Bill!" Sandy screamed, and leaped across the room. He tried to tear old Barnabas' clawlike hand away from his mouth. But he wasn't in time. The old man's gaunt face looked like a death's head as he grimaced at Bill.

"They'll never put me in prison!" he said. "I'll be dead in sixty seconds. You're the only man who ever beat me completely, Bill!"

His face twitched spasmodically while Bill tried to get a doctor on the telephone. Then he died.

"A Congressional appropriation, Bill!" Sandy said. "Gosh!"

"We'll need it," Bill said, his eyes on Barnabas. Suddenly he switched them to Sandy. "And *you*," he said. "You're grounded for sixty days for taking a Snorter out over the Atlantic on a night like last night!"

AIR PROGRESS

(Continued from page 7)

were recently delivered one month ahead of schedule. Portugal has ordered ten new Junkers Ju.52 bombers and a new aerodrome is being built at Torres Vedras to allow for the expansion of the service.

TRANSPORT

NEW RECORDS were made by all air-line operators in this country during 1936. 1,020,931 passengers were carried, showing a rise of seventy-six per cent over the previous year. Domestic air lines flew 63,777,226 miles in that time and carried 6,958,777 pounds of express.

"Air crashes," says Colonel J. Monroe Johnson, assistant secretary of commerce, "are due to our pioneering spirit. We continually overplay our hands; we keep our technicians, with their development, behind us, and not ahead of us. They cannot catch up with our needs."

British Airways Ltd., with a line between London and Sweden, have paid $300,000 for five Lockheed Electra transports. The explanation is that they cannot buy commercial ships in Great Britain, as all aircraft factories are working on air ministry contracts and are building only military planes. The new Lockheeds will be delivered in June.

American Air Lines has installed "storm windows" on their planes. The device consists of a sheet of light, transparent cellulose material, about 8 x 10, mounted inside the regular window glass on felt strips, which allows a one-eighth-inch air space between the two plates.

A Sikorsky S-42 was recently flown a distance of 1,552 miles from Santiago to the Straits of Magellan by two Chilian pilots in just over ten hours, which included one stop for refueling.

A special Italian Savoia-Marchetti S-77 has been built for trial runs between Rome and South America. It will use two 1,000 h.p. Fiat motors and have a cruising speed of 200 m.p.h. The first trip will be made some time next month.

SPEED RACE

THE apparent lack of interest in the coming New York-to-Paris Flight to honor the first nonstop flight between these two cities by Colonel Charles A. Lindbergh, can be accounted for in several ways: First, American pilots feel that the French Aero Club has "written the rules," to suit their own desires. The rule that all competing planes must be powered by two or more motors rules out planes like Frank Hawks' *Time Flies* and Howard Hughes' racer.

The European entries appear to be backed by the governments behind them. Italy is entering a flight of Savoia-Marchetti S-79s, which are bomber types with retractable undercarriages. They are fitted with three Isotta-Fraschini engines which develop 800 h.p. apiece. They have a maximum range of more than 4,000 miles and a cruising speed of 275 miles per hour, according to Italian authorities.

The British D. H. Comet, which was flown by Scott and Black in the Melbourne race in 1934, has been put up for sale in England. There is a big probability that it will be rebuilt by a sporting syndicate and flown in the New York-to-Paris race.

Three French machines have been entered with government backing, and there is a possibility of one German entry. Whether the United States will produce an entry in time, either through private means or through the government, is not known at this writing.

The Air Trails booth at the National Air Show, held in New York early in February, was one of the features of the highly successful display. Many noted pilots, authors and artists visited the booth. A framed oil painting of *Time Flies*, by Frank Tinsley, was presented to Frank Hawks by Clyde Pangborn.

Four American light planes will attempt a flight to India this summer. The group headed by Major Merrill K. Riddick of Dansville, N. Y., will lead the formation, which will cover Los Angeles, British Columbia, Alaska, China and India.

MODERN MOTORS

(Continued from page 25)

engines, or who, of late, have studied the present-day model aircraft motor, will thoroughly understand.

However, to make it clear we have offered a diagram of the two-stroke system. The drawing is done in the simplest form, for clarity. In the portion (1) we see the inlet and scavenging stroke; (2) the compression stroke where the air inlet to the crank case opens; (3) the top of the compression stroke with all ports closed; (4) the power stroke.

The simple type of two-stroke engines use the crank case as a preliminary compression chamber. The downward motion of the piston providing some, if slight, compression. Air alone is slightly compressed here, so that when the inlet port is opened, after the piston passes the opening, this partially compressed air surges up and into the compression chamber. The shape of the piston head has helped in directing the clean air to its place and the burned gases are guided out through the exhaust tube.

Once the new, clean air is compressed again, a charge of atomized fuel is injected into the compression chamber, which is spontaneously ignited. The high pressure set up in the combustion chamber forces the piston down for the power stroke.

The Junkers "Jumo" engine we have offered as a representative aircraft Diesel, uses this two-stroke principle. The Vee-12 Deschamps Diesel, made by the Lambert Engine & Machine Co., of Moline, which was designed by D. J. Deschamps of the Minerva Company in Belgium, also uses this two-stroke system.

A four-stroke system is in use on some aircraft Diesels. The American Guiberson, rated at 240 h.p., uses the four-stroke system, as does the British Bristol Phoenix. But in general it seems that the four-stroke principle is more widely used on larger Diesel plants designed for stationary and commercial purposes.

The four-stroke principle in Diesel design is practically the same as is used in ignition-combustion engines. Air is sucked in on the first stroke, compressed on the second, fired when the atomized oil is injected into the cylinder on the third, and the exhaust stroke follows.

Of course, the modern Diesel is a little more elaborate and efficient than the general explanation given so far. To improve the motor and to increase its horse power and general efficiency, the designers have had to work out suitable cylinders, combustion chambers, and injection nozzles.

In the early days the Diesel was a slow-moving beast designed for heavy work. The combustion chamber was a plain, open affair into which the fuel was injected either by air pressure or by some form of mechanical injection. But, in time, the engines became smaller and the rotative speeds increased, demanding more efficient cylinder and piston design and injection nozzles that would stand up under great speed.

It was found that for greater efficiency some system had to be devised to improve the mixture of fuel with the air. Concave-headed pistons were designed to mushroom the air in the cylinders. Some designers installed systems whereby the incoming air passed through the oil spray, while others went in for designs that gave wide turbulence to the incoming air in an effort to mix the two. But then it was found that any form of turbulence during the compression of the air, or during combustion, often interfered with the free burning of the fuel. Heat was lost to the piston and any heat loss lowered the efficiency of the engine.

To overcome this, some designers added a smaller combustion chamber, or actually divided the combustion chamber in which this turbulence was confined to the smaller, upper portion. Air was mixed with the incoming fuel in this "turbulence chamber" and forced out through a lower throat into the main chamber.

After that problem was solved through several forms of this so-called "turbulence chamber" the designers then went to work on the fuel-injection system, just as automotive engineers went to work on the ignition problems of the automobile.

In general, fuel may be fed to the Diesel in two ways: By air provided through a compressor; or the solid fuel may be forced into the compression chamber by means of a mechanical pump.

Air-injection Diesels are used extensively for large, slow-speed stationary and marine units. The system has many points in its favor, for it offers an immediate and clean-burning combustion. Also, an engine with air injection can be controlled over a wide range of speed and loads. The objection to the system is that an air compressor of two or more stages must be used, and the initial cost of such a compressor is very high.

The pump systems of a common rail, or an individual-cylinder type, appear to work well on aero Diesels. The common-rail system comprises a single pump which directs the fuel to a header or common rail under high pressure. Then, from this common-rail feed are carried individual high-pressure tubing pipes to the nozzles. In the individual pump system, a series of pumps are connected to each individual cylinder.

The nozzles which are used to inject the atomized fuel into the cylinders may have a single hole in their tip or a number of smaller drilled holes. The single-hole type will not clog easily, but the multiple-hole nozzle aids in atomization and mixing.

The problem of the Diesel, as far as its use as an aero motor is concerned, will be found in the fact that a compression-ignition engine must be so built to stand unusual pressure and stresses. For instance, the ordinary spark-ignition engine has a compression pressure of 120 lbs. per square inch and on combustion the pressure is about 450 to 600 lbs. per square inch. In the Diesel, the designers face a compression pressure of from 400 to 600 lbs. per square inch and on combustion, a pressure of from 600 to 1,200 lbs. per square inch.

Thus we see that ordinary design and spark-ignition conditions do not come up to the manufacture of Diesels. In general terms, they must be built twice as strong. This is reflected in the fact that the modern 1,000 h.p. radial engine weighs not much more than 1,000 pounds, or, roughly speaking, one pound per horse power. The Deschamps Diesel, one of the best of its kind, weighs 2,400 lbs. and produces 1,200 h.p., or twice as much per horse power as the spark-ignition radial.

There is no question but that the Diesel has reached the stage where it must be considered as an aviation power plant. The German Junkers "Jumo" has been in use on some of the Luft-Hansa Junkers airliners for months now, with no trouble of any sort. The 500 h.p. Clerget 14-cylinder radial Diesel has shown its worth on long cross-country and altitude flights in France. At the present time two are being prepared for an attack on the world's altitude record, and the French government has set aside a large sum of money to allow the designer, Pierre Clerget, to go further with his work.

The flights of the airships *Hindenburg* and *Graf Zeppelin* have shown us what the 1,200 h.p. Mercedes-Benz Diesels can do under most trying long-distance flights.

The United States has apparently taken over the Guiberson Diesel Engine Co., in Dallas, Texas, since the firm produced its A-980 aero Diesel, which obtained a department of commerce rating a few years ago. Officials of the firm inform us that they are working, under government supervision, on Diesels, the details of which are not to be announced for some time.

From this then, we must presume that this country *is* interested in the Diesel as a power plant for aircraft. How far they have progressed cannot be told, but the Packard firm has apparently given up its attempts, which began so brilliantly a number of years ago.

However, the Deschamps Diesel, which is a twelve-cylinder inverted-Vee engine, appears to be on a par with any of the best European plants. We have no record of its being used at any great length in any airplane, and we must presume that the firm is still experimenting with it—perhaps under government supervision and secrecy.

But let us look into a tried and tested Diesel and see what the modern aircraft compression engine is made of and how it works. We'll consult the drawing on the Junkers "Jumo" again. We selected this because we were able to get suitable photographs and information to use in this article, also because it is one Diesel that is actually being used regularly on recognized air lines.

This Diesel is listed as a six-cylinder, vertical, opposed-piston, compression-ignition, two-stroke motor. That mouthful perhaps requires some explanation. In the first place, it is obvious that the engine has twelve pistons but only six cylinders, so that the pistons are opposed, not the cylinders. An opposed-cylinder engine has a cylinder and piston on both sides of the single crank shaft and in line with each other. It might even be called a 180-degree Vee engine. The opposed-piston system enables the designer to obtain more power without greatly increasing the engine size, by placing two pistons in an open-end cylinder. Combustion takes place between the two piston heads, forcing the pistons to opposite ends of the cylinder.

In the Junkers Diesel the opposed pistons in each cylinder compress air between them on their inward stroke. Fuel is pump-injected at, or near, their common dead center and ignited by the heat of the compressed-air charge. Combustion and expansion occur on the outward stroke, but before the end of this stroke one piston uncovers the exhaust ports and shortly after this the other piston uncovers the inlet port, through which a rotary blower forces fresh air, the spiral motion of which scavenges the cylinder. On the return stroke compression begins again as soon as both sets of ports are covered, and the cycle is repeated.

Fuel is fed by means of fuel pumps set on the rear end of each cam-shaft housing. Each cylinder is supplied by two fuel-injection pumps operated by two cam shafts, one on each side of the engine. The fuel is injected into the cylinders in the form of spray, by four injector nozzles.

The engine is water-cooled and the radiators, when mounted on the Junkers G-38 are mounted in the wings, so that they may be raised or lowered according to requirements. An oil-cooling radiator is also used in this manner.

The manufacturing license for this motor has been purchased by the British Napier Co. and they have turned out a similar engine known as the Napier-Junkers "Culverin," which has a rated horse power of 720, as compared to the 600 h.p. of the German motor.

As a comparison with the in-line type, let us look at a radial engine under the Diesel treatment.

The American Guiberson is a nine-cylinder air-cooled radial Diesel in which the cylinders, crank case, etc., are built up in the ordinary manner. The fuel system consists of an individual fuel-injector for each cylinder. The nozzle is the open type, with a pintle or pivot pin within the tip. Fuel is fed to this nozzle through tubing from individual pumps situated on the rear half of the crank case. These are operated by a cam integral with the valve cam, and inject fuel under a pressure of 2,000 lbs. per square inch. The fuel reaches the pumps through passages drilled in the crank case, so that the fuel is warmed and liquefied in cold weather. The engine control not only lengthens the stroke of the injection pumps and thus regulates the amount of fuel fed, but also regulates the time of the injection according to the r.p.m. estimated for each throttle setting. The single lever thus replaces the throttle, spark advance and mixture control.

Lubrication has a double pump with both pressure and scavengering sections. The single-valve per cylinder is operated through a push rod and tappet, by a cam turning against the crank-shaft movement at one-eighth engine speed.

In the 260 h.p. ZOD Diesel of Czechoslovakian manufacture, we find another nine-cylinder radial using the two-stroke system. Here a centrifugal blower supplies air under pressure to an annular chamber, which connects with a circular passage surrounding the bases of each cylinder into which air is admitted at a tangent. Shortly before the pistons uncover ports in the cylinder walls, exhaust valves open and the contents of the cylinder are discharged. On the exhaust valves' closing, fuel oil is injected perpendicularly from cylinder heads and the correct degree of turbulence to the fresh air is imparted by the tangential entry and certain depressions in the piston heads.

Much interest is being shown abroad in the new British Bristol "Phoenix" Diesel engine built in radial form, which in recent tests aboard a Westland "Wapiti," weighing 4,564 pounds complete, made an altitude flight to 27,453 feet, under official observation.

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mental stage for more than ten years with the backing of the British Air Ministry. Details of its construction have not been made public, but it is supposed to turn out 415 h.p. at 1,900 r.p.m. and weighs 1,090 lbs.

With all these types showing work and power output—we must presume with some degree of efficiency—what is there to hold back the progress of the Diesel? We have seen that one of the main problems is the ratio of power to weight. If the metallurgists can give us lighter alloys, all this can be overcome.

The fire-hazard feature seems to be worth considering, but the opponents of the Diesel declare that there are not enough Diesels in actual use to be sure that the fire hazard has been materially lessened. We can only find out, of course, when planes powered with Diesels crash. Theoretically, however, it would seem that they should be freer from fire than a plane using a gasoline fuel and requiring an electric spark for ignition.

But when we say that the Diesel will be cheaper to run because it uses a cheap grade of fuel oil, the critics of the Diesel are really at their best. They claim that the only practical fuel for a Diesel, is the heavy oil left as a by-product after petroleum has been exhausted for the last drop of gasoline. Gasoline is expensive because of the cost of refining and because of the demand, while fuel oil is cheap because of the comparative little demand.

In other words, a barrel of crude oil can be converted into a high percentage of gasoline and a low percentage of fuel oil, or vice versa. So, if the refiner suddenly realizes that, owing to the increased use of Diesels, he has a greater demand for fuel oil, it is natural that he will have to change his prices for fuel oil to make up for his loss on what he would have gotten for the same barrel of crude oil had he refined it into gasoline.

So, that while a Diesel engine will run on almost anything—bacon fat, butter, lard, fish oil, and even vegetable oil—we must figure in practical figures. No air-line operator using Diesels would go out into the market buying tubs of butter for fuel. He will purchase the cheapest fuel oil he can buy, which happens to be the by-product from petroleum after it has been refined for gasoline. If, in the future, the Diesel is perfected so that it will replace the gasoline motor in cars, trucks, and aircraft, it is obvious that the refiners will raise their fuel-oil price to make up for the loss they face in not selling gasoline.

It may be all rather confusing now, but that is the argument many engineers have put up, and they may be right. At any rate, the Diesel may be a fine engine, but it still has many obstacles to overcome. But if it only overcomes the fire hazard, it will be worth something.

Next month we will go into the details of the world's high-speed engines and find out what makes them stand out above the others.

BOOMERANG

(Continued from page 22)

Pacific closed behind him. He compared that dash across Lower California, the Gulf of California, and over the province of Sonora with that last long mile a murderer must walk to the electric chair. But he was almost beyond thought now. His mind and his body were numb. He held the ship on its prescribed course like an automaton, making an occasional correction for drift.

When he was over the province of Sonora he began studying the lush vegetation beneath him, looking for the tiny airport where he was supposed to land. He hit it right on the nose, after forty minutes of flying. He picked out the large cross that had been laid out as a ground strip to guide him. He gulped desperately to keep from being sick as he circled the little field twice to read the wind sock.

With one last gulp he slipped the silver ship down on her left wing and fish-tailed it in for a fast landing.

Swinging around at the far end of the bumpy field he taxied back toward the lone wooden hangar that stood at the other end. Several nondescript men in dirty overalls were working over the single plane on the field. They stopped work to watch Hank come in, but turned away as he set his brakes near the hangar door. He was about to shout to them when two more men stepped out of a lean-to built on the end of the hangar.

Hank cut his switch as the men came toward him. One of the men was swarthy and shifty-eyed, like Olmer. The other was fair-haired and blue-eyed. They both looked as though they knew their way around.

"You're Brewer?" the swarthy man asked.

Hank nodded his head and watched the man with the fair hair circle the little fighter. His eyes were shining with admiration and Hank knew he was a pilot.

"My name is Martinez," the swarthy one said, "and this is Mr. Lund." He didn't offer to shake hands and Hank acknowledged his words with another nod of his head.

"How does she handle, eh?" Lund asked him.

"O. K.," Hank said and slid to the ground. He stretched his legs and arms to get the kinks out of them, as he had done a thousand times before after a landing.

"Let's go inside and get things settled," Martinez said.

Again Hank nodded. Then he began to laugh. Perhaps it was partly hysterical laughter, because for a moment he couldn't control it.

"There is something funny?" Martinez said and his dark eyes were suspicious.

"Yeah," Hank said, "there's something funny."

He was thinking of the books he had read about international espionage and the stealing of secret plans and information. In those books there had always been little Japs who hissed through their teeth, mysterious Chinese who appeared from nowhere with terrible instruments of torture, and silent, stealthy middle-Europeans who threw a knife with every breath. Also a dark-skinned beauty with flashing teeth and a rose in her hair who lured the hero to his doom.

Here he was in the midst of such an intrigue, and it was as prosaic as taking a street car downtown to get a haircut. He couldn't help laughing, yet he knew it was no laughing matter. He knew he wouldn't be laughing in a few more hours. He somewhat doubted if he would even be alive to laugh.

"You have brought the plane," Martinez said when they were inside, "and we will complete the transaction." He reached into an inner pocket and pulled out a long envelope.

"Anything tricky about handling her?" Lund asked. "I've got to take her out of here and you might as well tell me if there is."

"Nothing," Hank said. "She's fast and sensitive. You'll get the feel of her in a couple of minutes."

"Here," Martinez said, "is twenty-five thousand dollars in United States money. You had better count it. I want a receipt."

"What about the other papers?" Hank asked.

"I have them here," Martinez said. "I will give them to you after you sign the receipt."

"I don't sign anything," Hank said firmly. "There's the ship. That's your receipt. Olmer said you would turn the money and the—those papers over to me when I delivered the plane."

"I must have a record to prove the money was paid," Martinez said.

"May I see those papers?" Hank asked.

"I will give them to you after you sign the receipt," Martinez said.

"How do I know they are all there?" Hank asked. "Remember, the reason I'm here is because I was fool enough to put my name on those papers—not because you're paying me money."

"We will conduct this thing our way," Martinez said in clipped words. "The sooner we complete things the better it will be for you."

"Meaning what?" Hank asked, belligerently.

"Meaning, you won't get out of here alive," a voice said from a window behind Martinez.

The things that happened then happened so fast that Hank couldn't follow them. His eyes flew to the window from which the voice had come, as Martinez whirled. Hank was facing the window so he was the first one to see the red-faced man with the bulbous nose and iron-gray hair who stood there. He was leaning on the window sill and his hard-boiled face said he was enjoying the situation.

As Martinez whirled, his right hand dived for a gun in a shoulder holster beneath his coat. But it never reached the gun. An automatic flashed into the hand of the man at the window so fast Hank did not see him go for it. As it spat orange flame Martinez staggered backward and screamed. The fair-haired Lund put his hands on top of the desk and left them there. Martinez sobbed as he gazed at his shattered hand.

"Take the gun out of his shoulder holster and go over the other one," the man at the window said to Hank.

Hank obeyed.

"Hold 'em on 'em while I get through here," the man said as he put a leg over the window sill. "Those three half-breeds out on the field will be over here in a couple of seconds."

The three men in overalls appeared outside the office door as the man with the hard face opened it. He swung his automatic in a semicircle and scowled at them. Then he snarled at them in a patois that was a combination of English, Spanish, and Mexican.

"Get a rope in the hangar there and tie up these three babies," he said to Hank. "I can keep an eye on all of 'em."

After Hank had tied the hands and feet of the three mechanics he went back into the little office. The hard-boiled man was amusing himself by sneering at Martinez and Lund. Hank had never seen such hatred as he saw in the eyes of Martinez. His face was twisted into a snarl that would have frightened most wild animals.

"My name's Bronson, son," the hard-boiled one said, and he put out his hand. Hank shook it.

"You let these rats get you in a jam, eh?" Bronson asked.

Hank nodded his head. Bronson was studying him with eyes that were mere slits in his face.

"Who got you jammed up?" Bronson asked.

"A man named Olmer," Hank said. "I'm a reserve officer in the United States army and a civilian test pilot. I didn't know what Olmer was trying to do."

"They never do know," Bronson said, bitterly. "Olmer—alias Sorenson, Johnson, and Olsen. He's a slick worker. He's ruined better men than you."

"What do you have to do with this thing?" Hank asked. "I'll admit I'm dumb. I don't get things straight."

"I've been tailing these two babies for three months," Bronson said. "They've been hanging around this field for the last three weeks. I knew they weren't here to pick flowers or shoot crap. So, I kept an eye on 'em. It's lucky for you I did."

"I don't see how it's going to help me," Hank said. "I'm washed up. I can't go back. Do you know where that plane came from?"

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"Know?" Bronson roared. "Certainly I know. You've been framed, kid. What you should have done was slam this bird Olmer in the puss. You know what he is, don't you?"

"I know now," Hank said.

"Well," Bronson said, "do you suppose he'd want it advertised? You took a run-out powder. And you don't look yellow, either."

Hank's face turned the color of a weathered brick. His big fists clenched and unclenched.

"Listen," he said, "I'm not yellow. It was a matter of doing this or going to jail. And there was a—a girl involved."

"There always is," Bronson said shortly. "You young scuts ought to learn to keep your mind on your work. You got enough fuel to get that plane back where you came from?"

"Yes," Hank said. "But I can't go back now. I tell you I'm washed up." His voice rose a trifle on the last two words and Bronson glared at him.

"You're going to take it back," he growled.

"What about those papers he has? Hank asked, indicating Martinez.

Bronson reached over and lifted Martinez to his feet by his coat lapels. He dived his hand into his inside coat pocket. He brought out the long envelope, took the papers out and left the currency in the envelope. He handed the papers to Hank.

"Do you think these rats would have let you get away from here with that twenty-five thousand?" Bronson asked.

"I hadn't thought about that," Hank said.

"And they call you Long Hank," Bronson said. "You're supposed to be long on caution and courage. They ought to give you back a teething ring!"

"Listen!" Hank said again. "Who the hell are you? What's your in——"

"Me?" Bronson snarled. "I'm just an old wart who goes around getting babies out of trouble. When I get paid, the secret service pays me."

"You're Iron Mike Bronson," Hank said, and his eyes widened.

"You're quite a guesser," Bronson snapped. "Come on, get yourself together and get going."

"What about you?" Hank asked.

"Don't worry about me," Bronson said. "I'll tie these two snakes up and that'll give me a head start on getting out of Mexico before they catch up to me. I have a car parked down the road."

"What about that money?"

"I'll take that with me." Bronson laughed. "That'll keep these two out of mischief." His face sobered. He pointed a finger at Hank. "I'm letting you out of this jam," he snapped, "because I think you have the guts to go back, face it and clean it up. You can think up some stall for disappearing for a few hours, can't you?"

"Yes," Hank said, "but——"

"But, hell!" Bronson roared. "Get out there and get that ship warmed up. Olmer probably held a couple of those papers out on you. He'll try to use 'em. Outface him, kid. Show him you have some guts. Knock his teeth down his throat. You'll be surprised at the effect of a broken nose."

Long Hank stretched out his hand just before he took the little fighter off the ground.

"Maybe I'll have a chance to thank you again some time," he shouted.

"Maybe," Bronson said. "Keep your mouth shut and no one will ever know anything about it." He smiled at Hank, and for some reason his face reminded Hank of a red-faced Santa Claus.

Hank skimmed the trees on the far end of the field with the fast little fighter and took it upstairs with breathtaking speed. Five minutes later he had plotted his course back to the field in California.

On the way back he thought about the astounding stories he had heard about "Iron Mike" Bronson. Every officer in the army and navy had heard of Bronson and knew about his work.

Then, he began to worry about Olmer again. Suppose Olmer didn't back down? The thought sickened him. He wondered if he had the guts to cope with him if he didn't.

He made contact with his home field on the radio and told them a story about a clogged fuel line and a forced landing. He told them he would be in within an hour. He kissed the ground with his landing wheels just fifty minutes later.

Major Stephen Knox, M. L. Meredith, and that little knot of worried army officers crowded around him as he slid over the side of the cockpit. He was amazed at his own adroitness as he told them an imaginary story of a forced landing.

"It wasn't the fault of the ship," he told Meredith. "It was the fuel."

Fifteen minutes later he was alone with Major Stephen Knox. He looked at Knox and his eyes slid to the automatic Knox had strapped around his waist. That would be the thing with which to face Olmer, he thought. If Olmer was yellow he'd show it under the point of a gun. He reached out a hand and touched the automatic.

"Lend me that gat for a couple of days, will you, Knox?" he asked.

Knox turned and stared at him.

"Lend it to you?" he said. "What's the matter, Hank. You got something on your mind, too?"

"Too?" Hank asked.

"I guess we didn't tell you," Knox said. "Olmer shot himself about twenty minutes before you landed."

"Shot himself!" Hank said. "He's dead?"

"He's dead," Knox answered. "I was afraid you'd be shocked. That's why I hated to tell you. After you made contact by radio and said you'd be in within an hour Olmer went into the hangar. A few minutes later we heard a shot. He was dead when we got to him. He didn't leave any note or anything. He must have had something on his mind."

"Yeah," Long Hank said slowly. "He must have."

CRASH COURAGE

(Continued from page 30)

sound of the transport. The roar of the Wasps came like thunder through the haze. A thousand feet! The fog was stringy, now. Through a break in the wall of feathers, he saw it—the silver nose of the transport!

Harde hunched down. He was like a machine now, like a part of the fragile ship of rags and wire and wood. His hands were clamps holding to the stick. His feet were pistons, kicking at the bar. His eyes were rivets, holding him to the transport.

The Wasps bucked and jittered. Harde cursed. The gas was almost gone. He cut close across the nose of the big ship and the pilot signaled frantically. Harde swung back, and signaled for them to follow him.

Harde knew his chances. He looked down into that ocean of fog, and gulped. There was nothing there but swirling mist—long white fingers, reaching for him; bleached, white lips sucking him down. He jerked a look back, and stiffened. He couldn't see the transport!

Harde felt a chill of fear. He had turned too fast for the big ship. It was lost in the mist. What if he should ram it? What if he should hurl in like a catapulted thing, and knock the big ship from the sky just when he had a chance to save it?

In a panic, he skidded flat and screamed back, circling warily. He lifted up—up! He cut his engine and the throbbing roar of the Wasps came from right ahead of him! He was going to crash—going to smash head-on!

A cold sweat of fear drenched Harde. He was flying blind—blind as a bat. He jerked the stick against his stomach and screamed up in a tight loop. He threw the stick across and rolled out. Through the fog below him swam the white-and-silver wings of the giant, blind bird.

Harde cut down again, across the nose of the transport. The Wasps were cutting in and out, sucking madly for the last drop of precious fuel in the wing tanks. Harde signaled again, and this time he was careful not to lose the big ship.

But the fight wasn't over; it was just begun. There was no time now to make calculations. The big ship had to go down, and Harde had lost his bearings in his mad maneuvers to keep out of the way of the big, blind bird he was leading down.

Harde flew ahead, and below the transport. He fisted the mist from his eyes. Down—down—down into hell for all he knew. He sat hunched and stiff in the pit. His hands had stopped their trembling. His stomach had lost its sickness. He was again a cold, machine thing without nerves or heart.

Harde knew that Sykes was behind him, trusting him, following him. Sykes had to have a chance to live. It was up to Harde to give him that chance. Harde knew all this, and it kept drumming in his brain like a hammer. Sykes was unconscious, but he was trusting him.

Then he screamed. Through a break in the fog he could see the drome. They were going in the short way and they were still too high. They were going to overshoot the field!

Harde knew what he had to do. The transport was above him. Rogers might have seen the field in that momentary opening in the mist, and he might not have. Harde cut down swiftly, drawing the transport with him. Down—down—down!

Harde knew he was going too low. He was over the hangars. He was taking a desperate chance to draw the transport close enough to the edge of the field to give it room to land.

Fifty feet from the ground, the mist broke like a curtain. The wet field lay below them. Harde prayed that the transport could make it. In drawing the transport down close to the hangars, Harde risked a crash into the big sheds. He knew he was going to crash, but he didn't care.

Harde braced himself. He screamed wildly with glee and pent-up emotion. The hangar roofs seemed to leap at him. He saw the transport slide low across his head to the safety of the field. Then he struck!

He wasn't afraid, even then. He felt the Douglas buck and rear back. He was hurled against the panel as the belt broke. There was a grinding, tearing sound as wings whipped off. A black wall seemed to hammer into Harde's eyes, blinding him, knocking the senses from his lean head.

When he came to, the calm-eyed brunette from the lunch counter was holding a drink to his lips.

"I knew you'd do it," she said softly, "and Sykes needs his chance."

"Meaning what?"

"They're afraid to send that plane up again in this fog. Sykes has just six hours to make Chicago and live. Somebody's got to give him that chance."

Harde shook the bleariness from his eyes, shoved his way through the crowd that had gathered. He went over to the group at the transport dock.

Rogers was protesting, "It's no use, fellows. It's—it's suicide to go up in that fog again. I know."

Harde tapped him on the arm. "You've got the jitters, buddy. I've had 'em, I know. I've got my crash courage back. There are some things that you can't run away from, Rogers. You've got to fight. I'll fly to Chicago, if you'll give me permission."

Rogers straightened. With the inborn courage of the flying man, he said definitely, "I'll go with you, Harde. I haven't lost my nerve. There's a saying that if you once lose your nerve, you're done forever."

Harde grinned fiercely as he climbed into the ship. He knew that that saying wasn't always right.

GETTING INTO AVIATION

(Continued from page 18)

that way; they grow gradually. But an artificial supposition will serve our purpose.

If the air line were to be altogether within the United States, the Department of Commerce would provide airways with lights, radio-range beacons (radio beam), radio-marker beacons, intermediate landing fields every fifty miles, and radio and teletypewriter facilities for transmitting various messages and the weather reports gathered through coöperation with the United States weather bureau. Government personnel would build, maintain and operate these facilities.

Even if this elaborate outlay were ready and waiting, you would hardly know where to begin, so you would look around and hire the most experienced and capable expert in air transportation you could find to be general manager of your company. He would start hiring people and making purchases right away and that would involve opening an office and hiring a treasurer and clerical staff to handle the business end.

The cities on the line would most likely furnish terminal airports, with or without adequate buildings. If the line went outside the United States, procurement of airport facilities might even involve transforming deserted islands into modern airports. In any case, trained airport engineers and construction engineers would be needed, with draftsmen, electricians, carpenters and a whole force of other employees of varying skill. For maintenance and continued development of facilities a certain number would be kept permanently employed.

In some of the buildings would be installed elaborate and complicated equipment for servicing and maintaining a fleet of airplanes. An expert engineer, thoroughly familiar with such machinery and capable of creative work in helping to develop and improve it, would be hired as your superintendent of maintenance. He would have to know aeronautical engineering as well as mechanical engineering, and in addition would have to be able to recognize and direct effectively the various skills of a large staff of assistants.

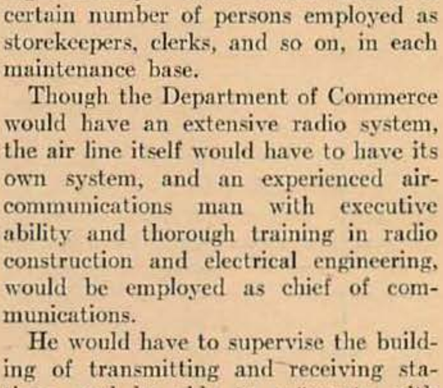
Under him would be men almost as thoroughly trained and experienced as himself, including maintenance supervisors, inspectors, foremen of engine overhaul, plane overhaul, metal shops, and perhaps woodworking shops. Under them would be airplane and engine mechanics, instrument men—if this work was not done by airplane or engine mechanics—welders, machinists, carpenters, woodworkers, and various apprentice mechanics and helpers. Your maintenance employees would have to be skillful, conscientious, intelligent, and absolutely dependable, for on them would depend the lives of every passenger and member of the flight crew.

Under the maintenance department might come also the work of operating a laboratory for testing materials, developing new devices and technical processes, and conducting various experimental projects with the aim of increasing efficiency. There would also be a certain number of persons employed as storekeepers, clerks, and so on, in each maintenance base.

Though the Department of Commerce would have an extensive radio system, the air line itself would have to have its own system, and an experienced air-communications man with executive ability and thorough training in radio construction and electrical engineering, would be employed as chief of communications.

He would have to supervise the building of transmitting and receiving stations, and be able to coöperate with manufacturing engineers in the development of new devices. Under him would be a staff of assistants, technicians, radio operators and maintenance men—though most repair work would be done by operators.

To conduct the actual business of carrying out flight schedules, your general manager would secure a superintendent of operations. This extremely important office would be filled by a man of high executive ability, with a thorough background of training and experience in the operation of planes in air transport, plus the creative capacity to coöperate effectively in the further development and improvement of techniques and equipment to advance safety and general efficiency.



This Waco cabin plane exemplifies the ships flown by the private pilot.

More than likely the man selected would have had experience as an air-line pilot and then transferred to the executive phase of operations work. He would be completely familiar with the business of air transport in all its aspects, for on him would largely fall the duty of correlating the functions of the various departments—all of which contribute to the process of getting airplanes with pay loads into the air and safely back to earth at their destinations.

Under the operations department would come the dispatchers. They would be expert meteorologists, and would know how to use the radio telephone and teletypewriter, and in general would be experts in the business of keeping track of all planes en route, giving pilots information, advice and even orders sometimes, forecasting weather, issuing clearances and so on. Theirs would be very responsible positions.

Under the operations department also would come the pilots, whose training we have already discussed and whose duties are no doubt better known to you than the duties of any other air-line employees.

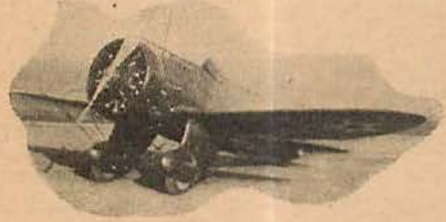
Also under the various operations executives would be assistant dispatchers, clerks for keeping flight records, and various other employees.

If you had complete airways and airport facilities, including maintenance and communications departments, fully manned by expert personnel, and if you had a whole fleet of brand-new 200-mile-per-hour airliners, with pilots, dispatchers, operations managers, everything, you would be ready to go—provided you also had passengers, express, and mail ready to go, too. And right there you and your general manager would face a big problem, the solution of which requires some of the most capable and best-paid workers in air transport. They constitute the traffic department.

Your general traffic manager would be a business man and a business getter, with all the intelligence, imagination and all-around ability which that implies. In many companies he holds the rank of vice president and is paid accordingly, depending on the size of the company. The man you selected would organize a highly efficient staff of assistants, including men in charge of mail traffic, express traffic, and passenger traffic.

Employees under them would include traffic representatives, who would promote the use of the air lines through advertising, programs before organizations of various kinds, personal contacts, and every other means at their disposal. Personality and imagination of a high order would be required. Handling the routine work would be traffic men and women making reservations and selling tickets, getting passengers and cargo to and from the airports, handling baggage, keeping records and doing various other things. Stewards and hostesses, the latter graduate nurses, who serve passengers in flight, would come under the traffic department.

This brief description of the organization of an air line makes it all sound much less complicated than it really is. There are various executives who are hard to place in any particular department, whose duty is to correlate the functions of the different departments. The lines of authority do not go merely from top to bottom in each separate division and come together at the top in the high officials. They also cross over here and there. For instance, a very important man is the field manager, who is often in general charge of all the activities of his company at one airport. Directly under him might be a field secretary, landing crew, laborers and watchmen.



Goal of the army pursuit pilots, the Boeing P-26A pursuit.

At a smaller airport where there was no large maintenance base, he might be in direct charge of servicing and minor repair work. He and his assistant might also handle airport maintenance. If the line was one with infrequent schedules, they might also have to handle dispatching and numerous other tasks. The radio man might be the assistant field manager. Thus you see that the variety of abilities needed for some jobs is greater than others, and in some cases very broad indeed. Practice is different on different air lines and different divisions of the same line, and general statements are often misleading.

Also, on some lines communications is directly under operations, and sometimes maintenance also comes under the operations manager. Especially is this true of smaller lines, and there again men of wide knowledge and experience are required, in posts both high and low.

The big air lines are really combinations of several air lines, each more or less similar to our imaginary line and operating as a division. Above the several division organizations in a big system is a general organization of executives, experts, engineers, and their assistants and clerical workers.

These may include general heads of the basic departments already described, and also a general public relations staff—publicity and advertising—a technical development staff—engineers who do general development work, arrange for new and better airplanes, and so on—a legal staff—lawyers who perform various duties and in the case of lines extending into other countries, carry on necessary negotiations with foreign governments—and a general financial staff—which handles accounting, taxation problems, insurance, employees' savings plans, collections and disbursements, and so on.

Thus you see that air transport is a complex business that requires employees with many different kinds of combinations of training and ability. Where and for how much money may a young man acquire the training necessary for a beginning in the various phases? What kind of training should he have in order to get ahead? And to what big jobs might he hope to advance?

There are two approaches to the matter of training for jobs in air transport. One is the narrow approach. A person using it concentrates on learning to perform one specific function, such as repairing engines, operating and maintaining a radio, or designing and testing aircraft, or flying airliners.

Such a specialist may get a job, but he may hope to be promoted to certain desirable executive positions only if he is able to broaden his knowledge through additional training. Generally speaking, a man can advance on the job in his own specific line, but has a hard time getting experience in other lines without off-the-job training.

For instance, it is expensive for the company to give an engine man experience in communications and other departments when he has had no preparation for it. Thus an engine mechanic might get to be foreman of engine overhaul, but unless he learned a good deal more than engine work, promotion would not be open along other lines as well. He could never be a field manager, nor would he be likely to advance to maintenance base supervisor or general superintendent of maintenance.

The other approach to air-transport work is the broad approach. Following it, you prepare yourself thoroughly in a number of related lines, and perhaps take special training in one before ever getting a job at all. Then your chances of holding a job, once gotten, and of advancing to any one of several high posts would depend on your ability to fight successfully for promotion with other similarly well-prepared men. Without the preparation, you would have a tremendous handicap to offset by extra energy, ability and outside study. And the task might be too much.

In the first two articles of this series we listed the courses required of a pilot taking additional work in air transportation or of a student taking a complete air-line pilot and executive course at a professional grade aeronautical school. Such thorough training, which includes preparation in airplane and engine maintenance, communications, meteorology, navigation, operations procedure, elementary engineering, general air-transportation management and other subjects, is intended to equip a man to compete advantageously for promotions along any one of several lines, up to general-operations manager, or even to general manager of the air line.

For those who do not expect to fly, the same training, but with flying left off, may be had at one of the professional grade aviation schools. It comprises from 2,500 to around 3,500 hours of lecture, shop and laboratory instruction, depending on the school, and requires two years to complete. High-school graduation only is required for admission. Tuition for the two years—no living expenses included—runs from about $1,000 to about $1,200. Or training of the same general nature, though probably not as thorough or well organized, might be secured from a combination of other aviation schools and universities. The Bureau of Air Commerce will send free on request a list of aviation schools approved by it, and also lists of other schools and universities giving courses in aviation.

Let us suppose, then, that you had secured your broad preparation. With or without flight training being included, you would be prepared to start in the maintenance department as a mechanic—or assistant mechanic—in the communications department as an assistant radio operator; or in the traffic department as an assistant traffic man—though a man intending to work in traffic does not have to have the mechanical and technical training. Operations are somewhat different. With broad preparation, including flight training—and a transport license—you would be ready for a job as co-pilot. And without the flight training you might be an assistant dispatcher.

But most of the good ground jobs in operations, such as operations manager and chief dispatcher, are likely to be taken by men with air-line flying experience or with more extensive training in meteorology and perhaps engineering. You might get on as assistant dispatcher, but, with preparation such as just mentioned, it would be hard to advance to the higher posts in operations.

Since a good many executives are chosen from among the pilots, let us suppose that you had included flying in your broad training and that you went gunning for a co-pilot's seat. You would find that jobs, though not plentiful, are increasing. In 1934 the total number of pilots employed by United States air lines was about 750; by the end of 1935 the number was 987, and by the middle of 1936 it was 1,124.

You would also face the fact that

the number of pilots is not increasing in proportion to the number of passengers carried. This is due to faster ships in which a pilot flies more miles in the 100 hours a month or less allowed him. And with bigger planes fewer trips have to be made. Those huge 40-passenger Douglas DC-4s being built for five of the biggest air lines won't help the pilot employment situation any, though their use as sleepers, carrying 20 persons instead of 40, will offset the effect to some extent.

You would be sure, however, that regardless of these developments, pilots will continue to be needed and probably in large numbers as the industry grows. And a good omen for the future of the broadly trained man is Pan American's policy of the "multiple crew" for those 21-ton ocean flying boats. Under this policy, every man must be able to perform the duties of any other member of the crew. That means that every crew member is a transport pilot.

But the catch, for a lot of pilots, is that every pilot, even the lowest of the six grades, the apprentice pilot, must be a graduate aeronautical engineer, a transport pilot, and not over 24 years old when he is hired! Perhaps as land planes grow larger there will be openings for more than two pilots on each ship. And all pilots may eventually be required to be engineers, but that is not yet the case on the inland lines.

Engineers, however, have better chances in competing for jobs. Department of Commerce regulations require only that a co-pilot, under present usual conditions, have a transport pilot's license.

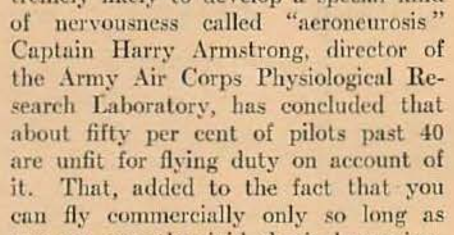
About fifty per cent of your time as co-pilot would be logged as solo time. And you would normally have a chance to build up your experience gradually to the point where you could secure a Department of Commerce "scheduled air-transport rating," which is required of all pilots in command of interstate air-line planes. The requirements are: at least 1,200 hours of solo-flying time, including at least 500 hours of cross-country flying and 75 hours of night flying with half of it over lighted airways; ability to pass tests in use of directional radio and other airway aids, in instrument flying, and in weather analysis and forecasting.

Air-line pilots are paid different amounts, varying with the number of miles flown, nature of terrain, night flying time, length of service, and so on. The average—various estimates disagree—for first pilots is between $540 and $650 a month. Co-pilots average between $200 and $250 a month.

Pan American Airways has a special system of its own. An apprentice pilot, though already an aeronautical engineer and a transport pilot, is put through a rigorous course of training. When he is, in addition, a qualified international traffic man, a licensed engine mechanic, a licensed airplane mechanic, a licensed radio operator—second class—a licensed radio construction engineer, a licensed mariner, and a master seaman, he is promoted to junior pilot. After that he goes on studying and getting experience, and may become successively flight engineer, first officer, captain, and finally "master of ocean flying boats." Captains must have at least 7,000 hours' transport flying experience and masters have to be real masters of every phase of ocean flying.

Attractive as the pay of first pilots is, flying jobs are not as well paid as a few of the executive posts. What is more, flying, though continuingly fascinating to many pilots, has certain unattractive features about it. Pilots who fly constantly year after year are extremely likely to develop a special kind of nervousness called "aeroneurosis" Captain Harry Armstrong, director of the Army Air Corps Physiological Research Laboratory, has concluded that about fifty per cent of pilots past 40 are unfit for flying duty on account of it. That, added to the fact that you can fly commercially only so long as you can pass the rigid physical examination, means that a man ordinarily may not be very sure of holding a flying job much beyond the age of 45—when men in many occupations are enjoying their most productive periods.

As mechanical flying aids are perfected and as planes grow larger, the day may come when the oldish captain —or "master"—of a great ship, with eyes not as good as formerly and muscular and nervous coördination not as perfect, may get a big salary for exercising his experience-gained judgment in telling less experienced younger pilots what to do.



The sleek Seversky, mount of the expert pilot, affords the ultimate in performance.

And the big ships, with crews organized more like those of steamships, may not be so injurious to pilots' nerves. But under ordinary present conditions a pilot must give thought to transferring to ground work.

The normal line of promotion for a first pilot is on up through the posts of station manager, chief pilot, division superintendent and general superintendent of operations. (Designations of posts vary with different companies.) Pilots quitting flying from choice—or as a result of failing the flying physical examination—often face competition of non-fliers for executive jobs, even in the operations department, though most operations executives at present are former air-line pilots.

If the pilot has had broad and thorough training, he may get an executive job in maintenance or communications or traffic, but here he will face much stronger competition from non-fliers who have had special training and experience in those departments.

First pilots taking ground jobs also find that the number of executive posts paying more than $500 a month is extremely small. And they have no assurance of not having to take a considerable cut in pay. Operations managers are paid in the vicinity of $475 to $525 a month. Dispatchers and meteorologists are paid up to about $275 a month, an Air Commerce survey showed, though chief dispatchers may be paid more by some lines Some dispatchers, usually assistants, get as low as $100 a month.

Dispatching has developed recently into a complex and highly difficult and responsible position on lines where schedules are frequent, and the tendency is to shift more responsibility from the pilot to the dispatcher. A special nine-month course in dispatching, including extensive work in meteorology and courses in air navigation communications, airplane performance appreciation, psychology and other subjects. is now being offered by the Boeing School of Aeronautics, which is a division of United Air Lines. This course is open only to graduate aeronautical or mechanical engineers.

Department of Commerce regulations do not require engineering training for dispatchers, but do require that all dispatchers be approved by the Department and have at least one year's experience as dispatcher or assistant dispatcher, or have served as a first pilot. In addition, a candidate is required to demonstrate a thorough knowledge of the utilization of all weather reporting and meteorological services, regulations governing air-line operations, nature and peculiarities of terrain and obstructions to flight on his division, air navigation aids and facilities used in the aircraft and on the ground, contents of the company's operations manual, and qualifications and characteristics of all operating personnel on his division.

Dispatchers who have not had piloting experience are nevertheless in a good position to compete with pilots for the higher executive posts in operations and general management, provided their ability and general knowledge of air transport stacks up well in comparison with the pilots.

We have already indicated that the

important qualifications of traffic men are a general knowledge of the air-transportation business, plus general education, personality, selling ability, and aptitude for meeting the public. College training, though not generally required, is very valuable. A man would naturally work as an assistant until he learned the ropes. After that promotion might be to field or ticket-office man, to traffic representative, to district traffic manager, to general traffic manager, or perhaps vice president in charge of traffic. Traffic men are paid widely varying amounts, but to give you an idea, a Bureau of Air Commerce survey showed the pay, not counting the high executives, ranging from about $100 to about $200 a month.

Air-line hostesses, of which between 250 and 300 are employed, are required to be graduate nurses by most lines. They are paid varying salaries in the vicinity of $120 to $150 a month. Stewards are used by Pan American Airways and about 40 were on the pay roll last year. With the coming of the superliners, with bars, more elaborate food-serving facilities, berths, and so on, hostesses and stewards may be hired in greater numbers.

Fortunately for young men who do not have the money to take the rather expensive broad courses we have described, training which will fit them to take jobs in the maintenance and communications departments may be had free—and with living expenses and pay thrown in—by a limited number in the army and navy schools.

Next month and the month after that we will tell you about mechanical, radio, photographic, and engineering training of various kinds available in military and civilian schools, and also about jobs for which such training is required in air transport, the services, manufacturing, and private operations. Some of the biggest jobs are in these fields, and prospects for the future are brighter than ever before. The news from the factories is especially good just now.

Floor space is being doubled and tripled. More jobs for workers and engineers with certain qualifications are open than there are men to fill them. And with sales of private planes mounting, and with the "flivver" plane on a mass-production basis supposedly just around the corner, many authorities believe the present rapid expansion is just the beginning.

(TO BE CONTINUED.)

"DEAR HARRY"—

(Continued from page 26)

Kelvin turns a white face and grins a sickly grin.

"I just remembered," he says weakly, "being told it is sometimes hard to judge your height over water."

"Yeah?" I say. "Then this must have been one of the times."

Anyway, the plane is still intact, so we pull off our outer clothes and spread them on the wings to dry.

"Let's swim," suggests Kelvin.

We dive from the pontoons, race, submerge, practice different strokes and have a fine time. It is a new sensation for me to be so far out in the water, with the shore only a dim line in the distance. Querying Kelvin I find that he has the same feeling, being, like myself, only a fair swimmer.

Traveling some distance away from the plane we tread water for a few minutes.

"Just think," Kelvin says, "if the ship wasn't there our lives wouldn't be worth a nickel."

I start to say something and nearly swallow my tongue in alarm. A breeze has come up. The seaplane is swinging around, drifting away!

"After it!" I holler to Kelvin and we foam in pursuit. Our progress seems slow. The breeze is stronger. It is sailing the plane away at a faster rate—faster than we can swim!

Treading water again we look in consternation at each other and at our surroundings. Boy—what a chill strikes me. We are alone in a vast expanse of water, above the water now, but before long—will we be beneath the surface?

"Look!" Kelvin yells. "The ship's coming back."

It's true. The wind has veered. The seaplane is drifting back in our general direction.

Strengthened by new hope, we swim at top speed. Both of us are tiring fast, but those precious pontoons are coming nearer when—the wind changes again and the plane sails away.

"I'm done," Kelvin gasps. "I can keep myself up but that's all."

I am not entirely exhausted. Alternately watching Kelvin and the ship, I wait for another change in the wind—if there shall be another.

There is.

Swimming slowly, conserving my strength I strike out for the point where my deductions say the seaplane will pass.

At first it seems that we will meet. Then I see that it will not be so. The ship will drift by me at a distance of twenty-five—no—fifty feet. Breaking into a sprint that must be my last I make all possible speed.

The splash of water, the gasping of my breath are the only sounds.

The plane is drifting by me, separated by a good thirty feet of water! Fairly throwing myself forward I force my arms and legs into rapid action. I am gaining. My hand touches a pontoon, slides off the smooth surface.

Now or never!

I fling out both hands at a strut—grasp it—pull myself over the pontoon.

For the next two minutes I just lay there while the blood pounds in my ears and my exhausted muscles slowly regain strength.

Then I think of Kelvin.

His head is still above the water, but he does not answer my wave.

Into the cockpit. The starter whirs. The motor fires. The ship taxis to Kelvin's side. I drag him, half conscious, onto the pontoons and he passes out completely.

Has he swallowed any water? He must be taken to land at once. After a resting spell I am able to boost him into the front cockpit.

His left arm falls lifelessly onto the throttle lever—and moves it ahead!

The motor thunders out. The propeller blast tears at me. I reach frantically for the throttle lever. Kelvin's arm covers it. I lean over him. A jerk of the ship, my foot slips and I fall into the water.

Never did I move so fast before. Even while falling I thrust out my arms and catch a strut fitting.

The seaplane is taxiing fast, towing me through the water. By the time I have climbed back on the pontoons the speed is greater still. As I grip the cockpit edge to vault inside, the pontoons leave the surface of the lake.

The plane is flying—with no one at the controls!

Instinctively, I grab the stick—bring up a sagging wing just in time. The ship is roaring away with a wide-open motor.

I dare not try to get in the cockpit. In the seconds required the seaplane might plunge into the lake. I hang to the side of the fuselage, eyes almost blinded by the terrific force of the propeller wash, but managing to keep the wings level.

At least I can retard the throttle. That done, the plane slackens speed. Cautiously, I let it lose height and then close the throttle entirely. The pontoons strike heavily, submerge, come up again and ride over the water with decreasing speed.

Into the cockpit I go.

Arrived back at our starting place I taxi up near Martin's landing and cut the motor. As I stand up in my cockpit Kelvin stands up in his. The cool breeze from the prop has brought him to.

"What happened?" he asked.

Discovering that my knees are weak I tell him sitting down.

But that very afternoon Kelvin proves he has a short memory.

At the time I have not yet recovered from the effects of the seaplane episode. Goose flesh is still standing out on me and every now and then when the memory of that last desperate lunge for the pontoons comes back I shiver mightily.

Therefore, when Kelvin's father makes a surprise visit to the field and Kelvin takes up a ship to show him how he can fly I expect to see some moderation observed. This in consideration of the fact that the gentleman in question went through experiences as harrowing as my own.

At first it seems that I am correct. Kelvin performs loops, barrel rolls and climbing turns at a safe altitude. Then he gets a little reckless, power diving and pulling up a few feet above the spot where his father is standing.

Then he gets real reckless.

Down he comes amoaning, flips over on his back and nearly crashes a hangar. Up again in a steep climb and into a tight spin. The plane winds around slowly, dropping fast. My heart is in my mouth. Will he never get out of the spin?

He does—three hundred feet from the ground.

Up to one thousand feet. He dives vertically, roars across the field at an altitude of ten feet and—he does it!—flies between two hangars with inches to spare on either side.

Down again at full throttle. He snaps into a vertical bank, roars away. The ship staggers—recovers, continues on, trailing a broken telephone wire from its wheels!

Norwood is jumping into his plane, warming the motor. I know why. He intends to go up and order Kelvin to land.

But Norwood never takes off.

Kelvin comes streaking for the field in a long, slanting dive. Instinctively, I realize what he is going to attempt. He will try to roll his wheels on the field while flying at full speed.

On he comes like a comet. His wheels are dropping, dropping, dropping. They touch the runway. The ship rolls a hundred feet. Kelvin triumphantly lifts it into the air again. He turns his head, waves to his father—turns back and finds the concrete office building staring him in the face!

Back with the stick. He tries to escape with a zoom. The plane rises sharply——

Crash!

The landing gear strikes the edge of the roof. The plane seems to pause in full flight—turns over and hurtles to the ground on the other side of the building.

I lead the race to the wreckage and help to extricate Kelvin's seemingly lifeless form.

And to-day I am sitting in Kelvin's hospital room, where he is confined with numberless fractures, when in walks his father.

For a moment Kelvin, Sr., remains silent, chewing on a cigar. Then he takes the cigar out of his mouth and speaks just fourteen words.

"Son," he says, "I'm going to terminate your flying career before your flying career terminates you."

And shortly after Kelvin departs for home on a stretcher, never to return.

All of which leaves me with an iron-clad resolve. It is that when, and if, my dad ever visits Skyways Air School I will *not* show him how I can roll my wheels on the field while flying at full speed.

Yours as ever,

STEVE.

FLIGHT-TESTING GAS MODELS

(Continued from page 41)

The best method is to get your model to perform with the minimum of angular settings. I have used successfully the following adjustments in some of my models: stabilizer set at zero angle of incidence, the wing at approximately 1 degree positive, and the rudder adjusted to turn the model with torque. Incidence can always be added if the ship does not have a good climb, but excessive incidence cannot be removed once the ship is diving for the ground after a severe stall resulting from the induced, steep climb.

The wings should have ample dihedral to overcome any unstable properties that may exist in the design. It has been found that a model with ample dihedral proves to be simple to adjust and fly, while the flight characteristics are never in the least impaired. My designs have often had as much as 15 inches dihedral, and when replaced with a wing of moderate dihedral, no change in performance was noticeable. In fact, the ship with the high dihedral flew more steadily on windy days and was a better all-around performer in all kinds of weather. In order that the tail and wing be kept in their respective positions, make sure that they are mounted rigidly.

The landing gear must be placed well ahead of the C. G., because the landing characteristics of models are different than those that exist in large airplanes. The model has no pilot to flatten it out when coming in for a landing. The tail is lowered on the real plane, so that it actually stalls in for a landing.

After your model has been completed you should not be overanxious to fly it. You should go over the entire ship, familiarizing yourself with the adjustments, paying particular attention to any warped surface in wing surfaces or stabilizer. If such is the case, do not let it worry you too much, but sit down and calculate how you are going to compensate for the situation. A little warp in the wing can actually benefit the flight of the ship, if you know how to control it.

The first good weather that you get, take the model out, above all things, not getting excited. Take your time in checking the assembly. Prior to the initial test flight leave the stabilizer, for the moment, at zero angle of incidence. Disregard the setting of the wing and motor, temporarily adjusting both at heavy negative incidence. Station a friend, preferably one who knows something of gas models, about 50 feet in front of the model and another helper in back of you. Their job is to observe the actions of the model as it scoots along.

The negative settings of the wing and motor will prevent the model from getting off the ground. Your job is to run alongside the ship as a safety precaution. If, after a few of these tests the ship taxis well, without erratic actions, gradually remove the negative incidence from the wing until the ship is making short hops off the ground.

After both the wing and motor have been brought to their correct setting, prepare the ship for a short test flight, with approximately 45 seconds gas. This allowance should enable your model to gain sufficient altitude for a safe recovery, should anything go wrong. If the model has been properly adjusted and balanced, it should turn with torque. A little rudder may be applied to make the circle smaller, so that when the power cuts out the ship will continue its circling flight. Visualization will make this clear.

The power given the model must be as little as possible during test flights. Never use all the power available, because that is a poor way to gain efficiency. Try to get as much performance from as little power as possible. When you have succeeded, your full-power flights will show a very decided gain over the low-powered flights, the model having been preserved by using the outlined testing steps.

Always make sure that the model can gain plenty of altitude before the engine cuts out. This will give it time to recover to a normal flight position; also, ample time will be allowed to study the flight characteristics of the plane. They should be marked down and used for future reference. Things that should be observed are: climb, turn with power, normal flight resumption after power has cut out, stability with and without power, glide and landing.

You should then check up with calculated performance figures and see how close they match actual flight figures. If the model has been carefully built, both sets of figures should check reasonably close.

The 1936 Texaco Contest Winner was handled in exactly the same manner here described, having never been flown before the day it won the championship. Of course, it would have been better to have tested the ship beforehand, but due to adverse weather conditions such was not possible.

This was the second National Contest that the writer was attending without having opportunity to test-flight the ship before the day of the contest. The first time was at St. Louis, in 1935, where the model was lost on its first official flight, after being kept in sight for 17 minutes. That flight taught a good lesson which will never be forgotten. When sufficient fuel for about 10 or more minutes of power is allowed, it is foolish to give the model all the power it has. This power will more than likely climb the ship sky high and out of sight in a few minutes. Depending on the fuel allowance, your model may have plenty of time to find a thermal, so adjust it to fly in a lazy, climbing circle. When it does hit a riser it will flow right in with it.

When I arrived at the field for the 1936 Nationals, the conditions for a successful meet were perfect. There was ample time to get my ship tested, so that it was about 3 o'clock before I decided to make test flights. Everything worked out as planned, and with about 45 seconds gasoline allowance, the model gracefully took to the air.

The climb was tremendous, for the little power that was on, the motor cutting out during the steepest part. I could tell you that this period was the hardest, but the load was quickly removed when the model leveled out slowly and even seemed to gain more altitude. The landing was as satisfactory as the flight had been, since it seemed that some one was actually at the controls, delicately bringing it in for a 3-point.

This test flight was more consolation than winning the Texaco Trophy, since, as I have explained, success hinges on the testing procedure.

STOUT TROPHY WINNER

(Continued from page 46)

PROPELLER

The 18-inch propeller, with its ample blade area, is a major item in the ship's performance. Any extra care given to the carving of the propeller will pay high dividends in better flights. The propeller block is shaped as indicated in the drawing. 1/4" camber is put into the rear face of the blades. The blades are cut to correct thickness and correct camber before rounding the ends. The full-size blade shape should be used to get the correct propeller shape. The template should be placed on the blade so that the leading edge of the propeller at the center is straight. That is, the front of the hub of the propeller should not be cut away. All excess wood should be cut away from the rear of the hub.

The propeller is highly polished so it will glint in the sun. Polish it with a fine grade of sandpaper and apply 4 coats of liquid wood polish. This polish can be made from 1 part banana oil, 1 part cement, and 1/20 part castor oil. The castor oil is added to prevent the wood from becoming brittle. After the last coat is dry to the touch, rub vigorously with a soft cloth. And at this point Leshner very amusingly added that, despite his forethought in making a shiny propeller, it never had a chance to glitter in the sunlight. The sun ducked behind a cloud and never once showed itself during his 36-minute winning flight.

FLYING

The model was adjusted to turn against the torque. The ship took off at a low angle of attack and gained altitude in about 200-foot circles. The glide was a tight circle—about 30-foot diameter. The sinking speed was remarkably low—a characteristic which substantiated Leshner's choice of airfoils.

The motor was wound outside the fuselage and then pulled through with a winding hook and attached to the propeller shaft and the rear hook. On the winning flight 550 turns were stored in the motor. And this is by no means the maximum number of turns. The power of the 22 strands of 1/8" brown rubber was so great that Ervin wasn't able to pack in any more turns with the small winder that he happened to be using at the time.

STOUT OUTDOOR TROPHY WINNERS

1930	Joseph H. Ehrhardt	*	No weight rule
1931	Emanuel Feinberg	29m 30s	No weight rule
1932	James F. Parham	4m 57s	I oz. per 50 sq. in.
1933	Maxwell B. Bassett	22m 22.5s†	1 oz. per 50 sq. in.
1934	James B. Cahill	4m 28.4s	1 oz. per 50 sq. in.
1935	Kenneth E. Ernst	20m 5s	1 oz. per 50 sq. in.
1936	Ervin Leshner	36m 1s	1 oz. per 50 sq. in.

The trophy was the gift of William B. Stout, airplane and motor-car designer. Stout was one of the country's early modelers and is still an enthusiastic follower of all modeling activities. Fuselage models are eligible for the annual contest, which is held under National Aeronautic Association rules and sanction. Stout is also the donor of a trophy for indoor stick models, which was put into competition about the same time as the outdoor trophy, and, like the outdoor trophy, has become symbolic of the best in modeling.

*Duration unknown
†Gas model

On previous test flights, with 300 turns hand-wound in the motor, the model made 5 consecutive flights of exactly 3 minutes. The flights were made in still air about 7 p. m. On these flights the propeller turned about 1 minute and 5 seconds.

FOR A CHANGE IN WEIGHT RULES

We've asked Ervin to tell us what changes he'd make in the model to adapt it to the new weight rules which more than likely will govern this summer's flying. He based these suggested changes on the assumption that the weight rule will be changed to 3 ounces per 100 square inches. That means a 50-per-cent increase in weight for the same area. Thus, with this ship of 208 square inches, the minimum weight would be raised from 4.16 ounces to 6.24 ounces. Since this model weighs 4.27 ounces, the increase would be slightly less than 2 ounces. This could be taken up with an increased length of motor, using a slack-rubber device to prevent the extra rubber from shifting back and forth in the fuselage and unbalancing the model in the glide.

To make better use of this increase in power a slightly larger propeller could be used. The fuselage of the model is strong enough to take the extra power and no changes in the structure would be necessary, other than a slightly larger rudder. Leshner has noted a slight tendency of the model to spin because of the weight of the rubber in the rear of the fuselage. This condition might become serious with a heavier motor. So to avoid this entirely, Leshner suggested that part of the 2-ounce increase in weight be used to increase the area of the rudder about 5 square inches.

Table of Weights

Fuselage	1.00	ounces
Wing	.80	"
Tail	.32	"
Propeller and plugs	.65	"
Rubber	1.50	"
Total	4.27	ounces

MATERIALS

Fuselage

6 pcs. $\frac{1}{8}$x$\frac{1}{8}$x36″ hard balsa for longerons and braces.

3 pcs $\frac{1}{16}$x$\frac{1}{8}$x24″ for fuselage braces.

1 pc. $\frac{5}{8}$x1$\frac{3}{4}$x8″ for wheels, plugs, etc.

2 pcs. bamboo $\frac{1}{8}$x$\frac{1}{4}$x9″ for landing-gear struts.

Short length of .045 wire for axles and $\frac{1}{16}$″ wire for shaft and rear hook.

1 sheet writing paper for landing-gear sockets.

Wing

2 pcs. $\frac{1}{8}$x$\frac{1}{8}$x24″ medium balsa for leading edge.

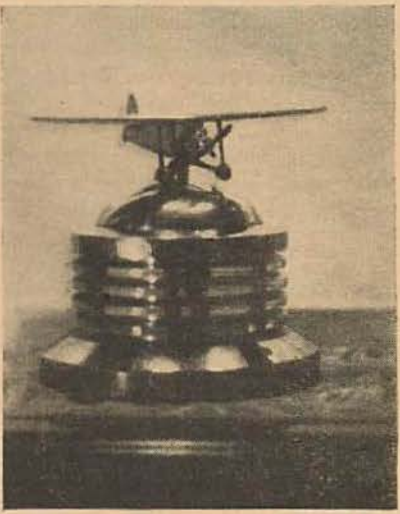
2 pcs. $\frac{3}{32}$x$\frac{7}{16}$x24″ for trailing edge.

4 pcs. $\frac{1}{32}$x$\frac{1}{8}$x24″ for cap strips of spars.

2 pcs. $\frac{1}{32}$x$\frac{1}{2}$x24″ medium balsa for spars.

2 pcs. $\frac{1}{16}$x$\frac{1}{16}$x24″ for rear spars.

1 pc. sheet balsa $\frac{1}{32}$x2x12″ for covering of center section.



The Stout Trophy, which is held this year by Ervin Leshner.

4 pcs. $\frac{1}{32}$x$\frac{5}{8}$x24″ for ribs.

Bamboo for tips.

Elevator

1 pc. $\frac{3}{32}$x$\frac{3}{32}$x24″ for leading edge.

1 pc. $\frac{1}{16}$x$\frac{1}{16}$x24″ for spar.

1 pc. $\frac{1}{16}$x$\frac{1}{4}$″ for front spar.

1 pc. $\frac{3}{32}$x$\frac{9}{32}$x24″ for trailing edge.

2 pcs. $\frac{1}{32}$x$\frac{1}{2}$x24″ for ribs.

Small length of .035 wire for tail hooks; bamboo for tips.

Rudder

1 pc. $\frac{1}{16}$x$\frac{1}{4}$x6″ for leading edge.

1 pc. $\frac{1}{16}$x$\frac{3}{16}$x7″ for trailing edge.

1 pc. $\frac{1}{32}$x$\frac{1}{2}$x7″ for tab.

2 pcs. $\frac{1}{32}$x$\frac{1}{8}$x6″ for cross braces.

1 pc. $\frac{1}{16}$x$\frac{1}{16}$x6″ for cross brace.

Bamboo for tips; soft iron wire for tab hinge.

Extra Items

1 propeller block, medium hard, 1$\frac{1}{2}$x2x18″.

1 ball-bearing washer.

Short length of .035 for free-wheeling spring.

70 feet of $\frac{1}{8}$″ flat, brown rubber.

Cement, banana oil, tissue, dope and castor oil, for making wood polish.

TRICK PHOTOGRAPHY

(Continued from page 36)

more carefully the better. Ink in any tiny white strips or white outline that are left around the figure with *black* ink. This tends to make the figure stand out.

Next set up a stage of white cardboard, using two cards, one for the floor and one for the background. If you wish to be more elaborate, you may draw a background similar to the one shown in the accompanying completed photograph. This will add depth to your picture. A good effect will be obtained without it, however.

Unless you have posed your picture carefully, it may be difficult to make both feet on your figure touch the floor. This difficulty can be remedied by bending the lower foot slightly, allowing the other to contact the floor surface. If necessary, the feet may be hidden behind a wheel. Naturally, the figure must stand up straight and must lean slightly against the plane at some point of support.

The lighting of the scene requires two light bulbs of one hundred watts each. One must be placed to the left of the scene, and one directly alongside the camera. Care must be taken that neither of the lights shines on the glossy finished surface of the image.

Using a piece of ground glass, focus the model into view by moving the bellows of the camera in the usual manner. When your figure is in perfect focus, you have the point for best results. Then simply close down the opening of the lens to its smallest diameter, say F.32. This gives the focus point a greater field of sharpness, covering from one end of the scene to the other with a crisp, sharp outline.

However, with this small opening, you must expose the film for fifteen seconds —or more. With Panchromatic film, the exposure can be reduced to ten seconds, this being a faster film under artificial light.

After you've finished placing everything, an operation that requires only a few minutes providing that you have constructed the necessary equipment, be sure that the shutter is closed. Then, after placing the film in its compartment, slide the compartment onto the oblong projection you've built to accommodate it, and wind the film to the first number. Cover the whole camera with a black cloth before placing the film, so that no light streaks are shooting through. Then turn out the lights, which should be controlled from one switch, open the shutter, turn on the lights for the correct exposure, moving nothing, then turn them out again. This done, the shutter is again closed. You then have a picture of yourself standing next to your model.

Be sure to remove the film compartment from the back of the box in darkness, and place it in a lightproof box somewhere at hand. Working in this manner, you can shoot the entire roll on all sorts of close-ups. This method works out as well for ship builders and other models in which you can place your own figure. The results are more than worth the trouble. And the technique may be adapted to make many types of unusual pictures.

WITH WHEELS OR PONTOONS

(Continued from page 48)

Complete the frames before removing. Cement the #14 music-wire prongs to the wing spars and, when dry, push the plain ribs (C. S. ribs) on the prongs of each wing up to and flush with the first ribs. Now attach the wing frames in position against the former extensions, forming the center section.

Is is best to block the fuselage up in neutral attitude (level), then pin and block the wing frames in place. Slip $\frac{3}{4}$″ lengths of $\frac{1}{16}$″ alum. tube on the prongs and then cement the tubes and the plain ribs to the former extensions. While the blocks and pins are still in place, make the struts and the #8 music-wire clasp fittings as shown in detail, and cement them to wings and fuselage as indicated. The dihedral angle should be approximately 2″.

Assemble two halves of the stabilizer and cement them to the detachable fuselage end. An auxiliary spar slot is provided in case you prefer to build the stabilizer as a unit, which is better. Assemble the fin-rudder frame and cement it on in neutral position. The $\frac{1}{16}$x⅛″ tail-surface ribs must be sanded to streamline before covering.

FINISHING THE MODEL

Dismantle the blocked-up frames and cement 7 $\frac{1}{32}$″ bamboo fairing strips to the top of the fuselage, as shown in the drawing. Cover the fuselage frame and fin-rudder frame with red tissue, including the balsa-covered portions. The pants and landing-gear struts are covered with red tissue, also. The wing and stabilizer frames look well when covered with orange tissue.

After the model is completely covered, attach the tail-surface bracing and spray the tissue with a fine mist of water. This tightens the tissue when dry. Now brush the whole model with two coats of thin model dope or good banana liquid. It is best to have the wings mounted on the fuselage while doping. Now is the time to add all the detail, such as the windshield, the head-rest fairings, radiator, lights, license numbers, etc.

PROPELLER AND POWER

Carve the propeller according to the pattern on Sheet 4. This is an unusually wide design, but provides for longer flights. Sand and dope the blades to a high polish. Attach the propeller to the nose block; fit the free wheeling, shown in detail, or one of your own design. Three loops of ⅛″ flat rubber is enough power for the model as a land plane and should be enough for the model as a seaplane. The original model weighs 1.5 oz. as a land plane and 1.6 oz. as a seaplane. No change in power was needed when the original model was changed to a seaplane.

The real Arrow is distinguished for its pleasing lines.

FLOATS

The float design is very simple and light, but important. Note the "hook" forward of the step and the bottom angles of the hull, fore and aft of the step, also the wide prow that minimizes digging in the water on steep landings. To preserve the important shape, cover the portion of the bottom forward of the step with $\frac{1}{64}$″ sheet balsa. After both frames are made thus far, cover them completely with red tissue, shrink them with water and, when dry, apply a coat of model dope and then a coat of clear or red lacquer to waterproof them. Cement ⅛″ sq. x 6″ streamlined spacers between the float centers and add the necessary wire parts to make them attachable to the model. The tops of the floats should be parallel with the top longeron of the fuselage when attached.

FLYING THE MODEL

Balance the model longitudinally one third back from the leading edges of the wings. Glide the model into tall grass until the resulting adjustments are satisfactory, then make full-power take-off tests in a field free of obstructions. After the land-plane version performs well, attach the floats and check the balance again. If the balance is the same, the model is ready for the initial water take-off. Do not get discouraged by the many duckings that will occur. The thrill of many happy take-offs and landings on water is well worth the trouble.

MATERIAL LIST

1 $1\frac{9}{16}$x2x2″ nose block
1 1x2x2″ prop block
4 ⅜x⅞x2″ pant blocks
2 ½x1x1″ wheel blocks

1 $\frac{1}{64}$x2x18″ sheet
4 $\frac{1}{32}$x2x18″ "
1 $\frac{1}{16}$x2x18″ "
1 ⅛x2x4″ "

12 $\frac{1}{16}$″ sq. x 18″
12 $\frac{1}{16}$x⅛x18″
2 $\frac{3}{32}$″ sq. x 18″
1 ⅛″ sq. x 18″
2 $\frac{1}{16}$x$\frac{3}{16}$x18″
2 $\frac{1}{16}$x⅛x18″

3″ $\frac{3}{32}$″ alum. tube
6″ $\frac{1}{16}$″ " "
1x3″ sheet celluloid
1 sheet red tissue
1 " orange "
1 oz. cement
1 oz. clear dope
2 dm. clear lacquer
6″ soft hinge wire
12″ #14 music wire
12″ #10 " "
12″ #8 " "
6″ #6 " "
5 ft. ⅛″ flat rubber
8 $\frac{1}{32}$″ sq. x 10″
bamboo

THE INSUROR

(Continued from page 56)

portant, as long as they are uniformly tapered. The propeller is shaped, using the blade pattern as a guide.

COVERING

This operation should cause no trouble if you follow a few simple directions. Cut four pieces of tissue each half the size of the wing. The grain of the tissue should run lengthwise. Next, iron all the wrinkles out of the tissue. Prepare the wing for the tissue by coating liberally with banana oil. Allow this coat to dry completely before attaching the tissue. Now give the wing another coat of banana oil. First attach the tissue to the center rib and the end rib, carefully smoothing out the wrinkles. Now attach the tissue to the leading and trailing edges, painting banana oil over the top of the tissue and rubbing it through with your finger tips. It will not be necessary to attach the tissue to the tops of the ribs. But it will be necessary to attach it to the bottom of each rib to maintain the shape of the wing.

If you're still inexpert at attaching tissue with banana oil, we'd suggest using a few drops of cement at the more difficult parts, such as the bamboo wing tips. Spraying the tissue with water will shrink it so tightly that it must be securely attached. A coat of dope should be given after the water spraying has completely dried. If necessary, banana oil can be used. But it would be advisable to thin it a trifle with acetone—which is available at most drug stores.

ASSEMBLY

The wing and elevator are attached, using 2 rubber bands for each. The elevator is mounted on the incidence blocks, while the wing is mounted flat atop the fuselage. 8 to 10 strands of ⅛″ rubber are necessary, depending on the weight of the model and the skill you've displayed in building the model. The formula for determining the amount of rubber for a pusher is to add additional strands until the model climbs steeply. A steep-climbing spiral is an important part of the single-pusher design.

Weights

Wing	.43 ounce
Elevator	.23 "
Rubber	.65 "
Propeller and frame	.94 "
Total R. T. F.	2.25 ounces

MATERIALS

Wing

2 spars ⅛x⅛x30½″
1 leading edge ⅛x⅛x26″
1 trailing edge $\frac{3}{32}$x⅜x26″
4 pcs. rib material $\frac{1}{32}$x½x24″
Bamboo for tips

Elevator

2 spars $\frac{3}{32}$x$\frac{3}{32}$x16″
1 leading edge $\frac{3}{32}$x$\frac{3}{32}$x12½″
1 trailing edge $\frac{3}{32}$x¼x12½″
3 pcs. rib material $\frac{1}{32}$x½x12″
Bamboo for tips

Frame

2 pcs. $\frac{3}{16}$x⅝x28½″
1 pc. ⅝x1x2″
Heavy wire for strengtheners
Scrap of ⅜″ balsa for incidence blocks

Propeller and Extras

I block 1x$1\frac{1}{14}$x11½″
Medium wire for shaft and rear hook
20 feet of ⅛″ flat rubber
Several washers
1 large sheet of tissue
Cement, banana oil, and dope.

—G. S. L.

SPRING FEVER

(Continued from page 40)

was coming in for a landing in left field. It was discouraging to lose the rudder of a new contest model, but the slight amount of damage was comforting, considering what the fast-moving baseball might have done to the fuselage or the wing.

But it took a fast-moving twin pusher to repay the insult which baseball had given modeling. The pusher was launched from the other end of the ball park, but it made a bee line for the second baseman. Relentlessly it bore down on its victim. The model was badly adjusted, and the extra power was all converted into speed rather than altitude.

For no reason at all, the second baseman turned around a few moments before the twin pusher reached him. His reaction was fast enough to pull his head to one side and allow the model to fly harmlessly past him. It was close, but the second baseman suffered nothing more serious than upset nerves.

Once in a while spring weather will let you down. I remember one time when I was disappointed. It was during Easter vacation. We had primed our models, intending to put in a few days of flying, taking advantage of our short freedom from home-work worries. Beginning the first day of vacation, the wind blew in galelike fashion and continued to do so for four days. Finally the air became calm, but only after we were again back in school, faced with the rather dismal outlook of more home work.

But, considering its good and bad points, spring weather still wins the verdict. Frozen fingers and numbed toes are not to be experienced during the next six months. We have a half year of good model weather ahead of us, not to mention a full list of contests. No wonder we are r'arin' to go.

EARLY AND STRANGE CONCEPTIONS OF FLIGHT

(Continued from page 34)

Between the years 1631-1687 the Jesuit, Francesco Lana, described a boat-shaped aerial car which, in a great many of its details, was similar to the flying chariot of Ki-kung. Contemporary with the ancient Chinese was Archytas, a Greek who lived about 428-346 B. C. He was a philosopher, mathematician, statesman, and soldier, and published numerous works. He was a skilled, practical mechanic and constructed of wood what was known as a "flying dove."

The description of his craft is very unsatisfactory. However, it is described as a wooden figure balanced by a weight suspended from a pulley and set in motion by a current of air hidden in its interior. Investigators are inclined to believe that this was the anticipation of the hot-air balloon or glider, as it is assumed from the record that it could fly but not rise again after falling.

In the old Arabic history it is noted that about the year 875 A. D., an Arabic mechanician of Spain, Abu'l Qásim Abbás Ibn Firnás, devised a mechanism to make his body rise into the air. It is said that he made a pair of wings, clothed himself with feathers, and flew some distance through the air. Apparently he had worked out the theory of flight, but not of landing, as he was injured in decent. Later in the same era Manuel Comnenus, a Saracen, demonstrated his skill before the Sultan of the Seljuks.

Comnenus climbed a high tower where horse races were being held with the avowed intention of flying across the race course. He used what was apparently, from its description, a clumsy but basically sound creation. The wing structure was of willow wood laid over a framework, the entire wing covered loosely with white cloth. It is recorded that he "soared like a bird" and seemed to fly in the air—a glider in effect.

Centuries later, Oliver of Malmesbury, an English astrologer and mechanician, who lived in the eleventh century, is recorded by Milton, in his "History of Britain" (1670), as having fitted wings to his arms and legs and having attempted to fly from a tower with the aid of the wind. He fell, broke both legs and attributed his failure to the lack of a tail.

Roger Bacon, the Franciscan monk, a great scholar and philosopher, points out between 1214-94 that:

> Likewise flying machines can be made in such a way that a man is seated in the midst of the machine, revolving some sort of device by means of which wings artificially composed may beat the air after the fashion of a flying bird.

In the past score of years many arguments have arisen as to who perfected the flying machine, and it is still controversial. However, in view of the research and findings of noted professors, curators, and investigators, it must be accepted that, in the prehistory of aviation, credit must be given where credit is due. It is a foregone conclusion that air craft was conceived and conceded practical a thousand and more years before the airplane and balloon were accepted as a possibility by our more modern sciences.

THE AUTOMOBILE ENGINE TAKES THE AIR

(Continued from page 33)

90-95 m.p.h. while the same number of revs drives the Ford car at a speed of only 59. The consumption is the same in either case—about 17 miles to the gallon. Standard 70 octane automobile gasoline is used, with a resulting saving in fuel bills. The oil consumption averages 2 gallons every 25 hours. This engine has proven extremely rugged and dependable and has been flown over 50,000 miles without even cleaning the spark plugs.

The Arrow Sport is a low-wing monoplane of conventional design. The large-area wing is of wooden construction, fabric-covered, and is braced by inverted V-type compression struts running to the upper longerons of the fuselage. The ailerons are weight-balanced and are generous in area. The fuselage consists of a steel-tube structure faired to an oval shape and covered with fabric.

Some pilots have found the cockpit a trifle narrow, but the side-by-side seat is otherwise very comfortable. Tipping the back of the seat forward reveals a canvas bag holding 28 pounds of luggage. A large, well-designed windshield obviates the necessity of goggles. Double wheel controls are provided, either of which can be quickly disconnected. The rudder pedals are conveniently placed and are fitted with heel brakes.

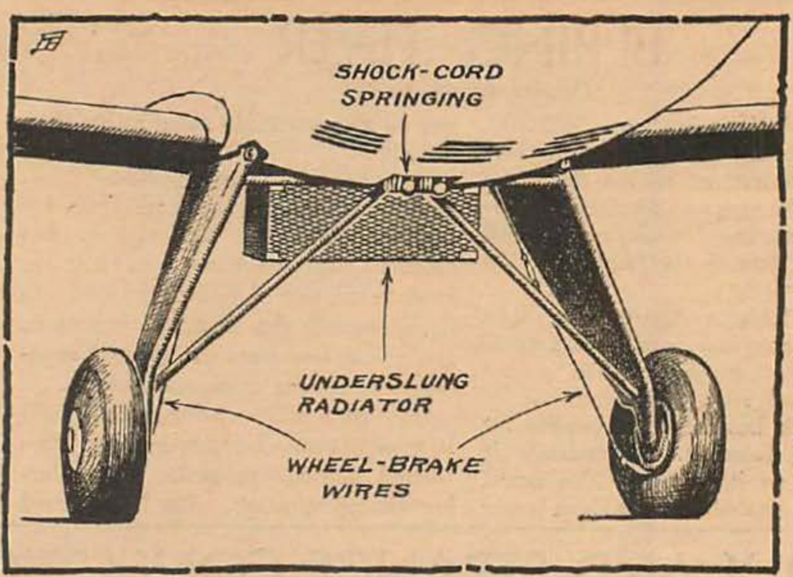
Standard equipment for the instrument board includes an air-speed indicator, altimeter, water temperature and oil pressure gauges, gas gauge, ammeter, switch, etc. A husky aircraft throttle occupies the center of the board. Additional equipment available includes brakes and tail wheel, electric starter, navigation lights and a cabin inclosure.

The ship is inherently stable and will take off and land "hands-off." The normal take-off run is 300 feet and the ship comes to a stop after rolling 200 feet. The original model was equipped with flaps. These were eliminated, however, when it was discovered that the prop, turning at 200-250 r.p.m., acted as an effective air brake. The explanation of

BILL RHODE
AERONAUTICAL COLLECTION

this apparent paradox is that the plane is gliding faster than the prop pulls, so that instead of being a source of power, the prop disk becomes a circular braking surface. Anyway—they say it works!

The Arrow Aircraft Corp. has worked more than three years developing this plane. They have turned out a good-looking, comfortable ship which is easy to fly and cheap to run. Ordinary repairs ought to be a cinch for the average young man with a knowledge of Ford cars, and the V-8 motor has a longer life than most aero engines. On the other hand, the Arrow is a comparatively big bus, with 82 horses and a gross weight of 1,675 pounds. Though she carries a bit more luggage, the excess weight of the power plane keeps her performance down in the class of light planes, developing half her horse power. The initial price ($1,500.00) is about the same as most of the lighter ships, but the upkeep cost is claimed to be lower. Which is the better bargain? You'll have to figure that out for yourself. All I know is that the Arrow Sport V-8 looks like another big step in the direction of a safe, cheap airplane for you and me and the little guy in the house down the street.



The shock-absorbing landing gear, though simple, is practical in design and sturdy in operation.

Span	36 ft., 9 in.
Length	21 ft., 4 in.
Height	8 ft., 10 in.
Area	180 ft.
Wing loading	9.3 lbs. per ft.
Power loading	20.4 lbs. per h.p.
Gross Weight	1,675 lbs.

Maximum Speed	112 m.p.h.
Cruising Speed	100 m.p.h.
Landing Speed	35 m.p.h.
Climb	800 ft. per min.
Serv. Ceiling	12,000 ft.
Range	300 miles
Useful Load	553 lbs.

Flying scale model plans for this ship appear on page 48 of this issue.

Indoor Equipment

(Continued from page 60)

disassembled model in the box and carry the box with care. Some builders have a modified version of Mr. Whalen's skyscraper and attach wings to movable dowels in the box.

All of these gadgets are applicable, to some extent, to other boxes, but attaching them is hardly worthwhile, as the life of a cardboard box is comparatively short. However, the cardboard box has one real advantage over the other types of carrying cases: if the cover of your cardboard box is strong and well-shellacked, it can be inverted on the armory floor, filled with water, and used to make microfilm. It is impractical to use the cover of a wooden box or fiber case, as it cannot be detached from the rest of the box. The cover, attached, will not be firmly supported, cannot be emptied without turning the whole box upside down, and water can be splashed into the box proper and onto the models that may be inside.

The accessories useful to an indoor builder are rather numerous. All boxes, without exception, should have a chart which gives the number of winds per inch of each size of rubber pasted in it in plain sight. A revised chart compiled for this purpose by Frank Zaic is included in this article. One of these charts will save you time, rubber, and possibly a ship, by telling you when to stop winding. Of course, every indoor builder has a winder. Ten-to-one-ratio winders are by far the most preferable, as the number of winds are easily known at any time, and the winding rate of a ten-to-one winder is just about right. Tests made on $^{7}/_{64}$" rubber have shown that a maximum number of winds are obtained when the winding rate is about 1,400 winds per minute. A greater speed—as obtained with a twenty-five-to-one—caused the rubber to break on an average of one hundred and eighty turns less. A slower speed was not only tiresome, but it also cut down the power, although the ultimate number of winds was not appreciably affected.

A fast-drying cement is always appreciated—especially when a ship is all wound up and ready to fly and you find a joint has loosened—and should always be carried. The cement will also probably be used to stick the model down in the box when you are ready to go home. Rubber to suit the models you intend to fly, of course, should be carried. However, it is a good practice to carry all sizes. There is always a time in every model builder's life when he forgets to take rubber for a particular ship, and always carrying all sizes will put this danger at a minimum.

Rubber lubricant should always be included, as it is now regarded just as important as the rubber itself. Not only does it increase the number of winds, but it lengthens the life of the rubber. If you have a box cover in which you can make film, you should carry at least one small frame and solution. If you have not, an old wing or tail should be taken along for patching. A spool of thread should be carried along to bind wing clips and stubborn wire fittings.

Several sizes of wire suitable for indoors, washers, a round-nosed pliers with a cutting edge, should likewise be included in the accessory kit. Several thicknesses of sheet balsa and a razor for minor repairs in structure will also occasionally come in handy. A metal ruler, which can be used as a straight edge for stripping wood—and incidentally to get dimensions of the other fellow's plane—can be included. If you go in for glider flying, your kit must have an ample supply of modeling clay for balancing your gliders.

Some time in the future a complete description of how to get your models off the rafters with a gas balloon—the safest method for both you and the model—will be described. It is by far too lengthy a subject to go into at present. A carrying kit for the generator, of course, should not be included in the model box, as any acid that might leak out will ruin the box in short order.

Discussion Corner

(Continued from page 47)

of the flight necessarily gives a slow climb and a low ceiling. As the motor unwinds and the propeller pitch decreases, the model stays at approximately the same altitude, until the motor is almost entirely unwound.

This argument does not consider the time needed to build a complicated adjusting device which weakens the propeller, adds weight, and is so delicate that it is difficult to keep in alignment.—Howard J. Ide, Grand Rapids, Mich.

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